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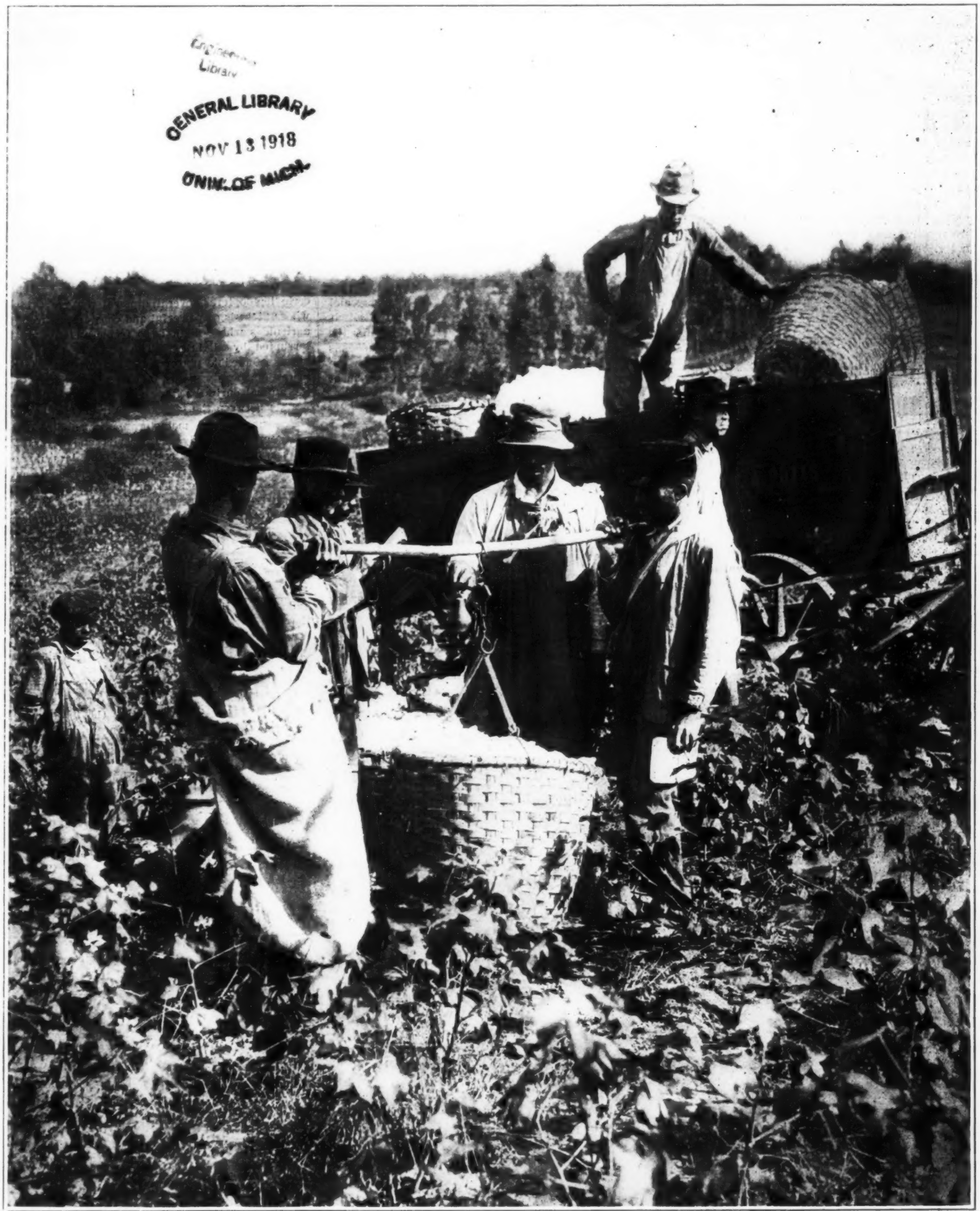

Cotton pickers are paid for their work by weight

KING COTTON HAS COME INTO HIS KINGDOM [See page 292]

Why Animals "Play Dead"*

A Study of Curious Phenomena in Insect and Animal Life

By Dr. Etienne Rabaud, Maitre de Conferences of the Sarbonne

When one suddenly seizes a cetinoid insect buried in the corolla of a flower it immediately folds its legs against its body, draws down its head and its antennae, and remains motionless. It retains this immobility, appearing to be entirely inert, no matter how one turns, twists and touches it. Other arthropods (crustaceans, spiders, myriapods, insects) behave in a very similar fashion when similarly struck.

This sudden and prolonged immobility after being touched has aroused keen interest in those who observe it; it has suggested to their minds comparison with death and it is a common saying that the animals are "Playing Dead." A phenomenon which is superficially similar has been likewise observed among vertebrates. The comparison thus made eventually was accepted as an explanation, so that it is now often said that certain animals "simulate death." In interpreting this fact some observers agree with Darwin that the immobility leads the enemy astray, that they appear not to attack dead creatures. Moreover the attitude and the coloration, together with entire immobility, often render the animal completely invisible, hence it can more readily escape those creatures which seek to make it its prey.

What is the nature of this immobility? At this point authorities begin to disagree. Various and contrary opinions are held. Some naturalists, there are few now-a-days to be sure, still think that this action is both voluntary and conscious in the arthropods as well as in the vertebrates. The majority, however, following Darwin and Romanes, recognize that it is scarcely reasonable to attribute this immobility to any idea of death, which would be the simulation of a state which is in fact unknown to the animal simulating it. It is far more probable that the immobility may be referred to an instinct very simple in origin. In the presence of either real or imaginary danger the animal may experience an intense and paralyzing terror; the complete immobility thus produced in place of being dangerous would on the contrary act as a safeguard for some creatures, if not for all. Whether they remain unseen or whether their corpse like appearance deceives the enemy, those who remain perfectly motionless for the longest time would have the best chance to escape. Having thus survived, their descendants would inherit the faculty of remaining motionless in the presence of danger, so that by the operation of the natural law of selection, the so-called instinct would be developed little by little.

This is the explanation most generally adopted. To be sure it has never been subjected to any test in the way of control experiments, which signifies that the phenomenon has never been thoroughly studied. As regards the vertebrata we have only very insufficient data proceeding from observations which were not only hasty and superficial, but misleading by their very evident anthropomorphic tendency. Even with respect to the arthropodes we know all too little, although more numerous observations have been made of these than in the case of the vertebrata. Various patient observers have studied some of the animals known to "simulate death," but instead of attacking the phenomenon in direct fashion, they have examined it only in its secondary aspects: its duration, its repetition, its frequency, the attitude and the state of the animal. Persuaded *a priori* that the fear of danger constituted the actual reason for the immobility, and accepting as demonstrated the hypothesis of a sensory point of departure, and more especially a visual one, these observers have deemed it useless to investigate the actual conditions of the immobilization; and yet it is just these which it is most important to investigate before everything else. Before constructing a theory as to the origin and the utility of immobility, it would have been preferable to define precisely when and how an animal becomes immobile, and what changes are then produced in its physiological condition.

The Immobilization of Arthropods: Taking this point of view as my starting point, and deliberately abandoning every explanatory hypothesis, I first undertook the examinations of some of the arthropods, which commonly "simulate death." These arthropods as we know become immobilized with great facility if allowed to fall on a hard surface. The question is whether this is due to the excitation of an organ or sense, or merely to a simple excitation of the general sensibility. Sensorial excitations of the visual order at any rate certainly have no part in this, as can be proved in various manners:

1. When we suddenly lift a stone under which myriapods are living, we find that among many individuals of the same species, some of them immediately roll themselves up, while others move more slowly.

However, all of them have been subjected in exactly the same way to a sudden passing from almost complete darkness into bright light; consequently, all of them ought to have immobilized themselves if it were true that the luminous radiations could produce immobilization by striking the visual organ. In fact, however, the myriapods which rolled themselves up were those which were somewhat suddenly displaced at the moment when I raised the stone.

2. When one lays hold *with precaution* of a phasmid orthoptera which has clung to a leaf or to a grating of the box it was reared in, it exhibits lively agitation, then rapidly moves its position if left alone. When one seizes it rather suddenly on the contrary or strikes it a smart blow, it instantly becomes immobile; yet there must have been as much visual excitation in the first case as in the second.

3. Some insects let themselves fall with amazing facility. Some very clever observers have believed that these insects see or hear some enemy approaching and remove themselves from danger by falling. I admit that anyone who observes this sudden falling for the first time without attempting to analyze the conditions under which it took place may easily obtain from the behavior of these insects the impression of a movement connected with vision, and to some degree voluntary; but on examining the phenomenon with close attention, we find that these insects are simply endowed with a very great sensibility to vibration of the air. The criocera poised upon an asparagus stalk for example falls as soon as the hand of the observer begins to approach it, even if the latter avoids shaking the branches of the plant in the slightest degree. Has the criocera seen the hand? Perhaps it has even seen the observer himself; but this matters little for the same thing occurs if the observer stands behind it and avoids making the slightest change in light and shade. However, it is possible to surprise the insect if one approaches it very slowly, so as not to cause too sudden a displacement of the air. In this manner I have been able to seize individuals between the jaws of a pair of pinchers which were in line with their eyes and even extended beyond their head. I was able to ascertain by experiment that visual excitations play no part in this phenomenon. In the habitual conditions sudden displacement of air, slight shocks, perhaps even thermic radiations preceding from the fingers are sufficient to cause the insect's fall.

It may be said then in general that the immobilization of arthropods results from a non-sensorial peripheric excitation. It may be observed also that the term sensorial should here be taken in its widest acceptation, which includes psychic phenomena. It is necessary, however, to state the case with more precision. The known facts would lead us to believe that any sort of peripheric excitation would provoke immobilization since any shock without apparent localization usually seems sufficient; but does this appearance really correspond to the actual state of the case? Precisely this is an essential point with regard to which I have conducted my researches—the essential point whose study alone will enable us to correctly analyze the phenomenon. We have been able to prove the capital fact that the immobilization results from the excitation of localized peripheric zones, and comparatively slight pressure exerted with a soft rod upon one of these zones would provoke in the arthropods a definite attitude which persists for a variable length of time. We have here, therefore, a reflex whose point of departure is independent of special sensibility. Experiments repeated on twenty-five species of arthropods, which readily take attitudes "simulating death," invariably gave me concordant results.

By their very nature these results appear to escape the commonly given explanation which ascribes the principal rule to natural selection, in reference to terrified animals. The purely reflex mechanism of the phenomenon, and its independence of sensorial centers as well as the localization of the excitable zones lead us rather to suppose the existence of a fundamental property of the nervous system, manifesting itself with a facility which varies according to the species and to the individual.

These considerations led me to undertake the systematic testing of the most various kinds of arthropods by a methodical exploration of the surface of their bodies. I succeeded in finding among a great number of them the place where the zones are located, whose excitation occasions a durable immobility. My experiments in fact involved more than one hundred and seventy species, and I have thus far encountered only a very small number which appear really to be refractory. The phenomenon, therefore, is sufficiently general in character. The immobilizing excitations vary in the different arthropods, not in their nature, but with respect to their localization. These localizations, moreover, do not correspond exactly in the various species; neither the conditions nor the resemblance observed in this respect bear a definite relation to systematic grouping, while insects belonging to categories as distinct as the lepidoptera, the diptera, the odonata, have homologous localizations. Other insects which are morphologically very closely related have on the contrary very different localizations.

The most widely found localization is at the root of the wing. Pressure upon this region whether unilateral or bilateral immobilized the majority of the rhopalo-ceric lepidoptera, several diptera, the great libellula, whose flight is so powerful and constant, as well as the agrienides whose flight is so feeble and frequently interrupted by alighting. The pressure is exerted by means of flexible pincers, which exert a strain of not more than twenty grams. It is often necessary to place the animal on its back, or merely on its side to avoid contact between the tarses and the surface beneath.

Pressure on the metasternum immobilized various coleoptera, especially the weevils and several heteropteric hemiptera. Pressure of the legs immediately arrests the extremely lively carabici, as well as the *Nebria psammodes* or the *Brachynus crepitans*. Pressure of the antennae produced the same effect upon the ants and certain long horned coleoptera. Finally, one can immobilize instantly on the spot the myriapods of the group of the Iulids by pressing the anterior rings. In all these animals the reflex may be released with surprising ease by very simple excitation. Among others this simple excitation is not sufficient, and some of them even appear quite refractory at first; the acridians and the locusts for example are very incompletely immobilized, or not at all by a mere pressure on the sternum; but by exerting simultaneous pressure on the metasternum and on the lateral portions of the thorax complete and durable immobilization is obtained. The maneuver presents no special difficulty; it consists in holding the insect while applying the jaws of a pair of pincers on one side and the other of the thorax, while at the same time we press upon the metasternum with a soft rod.

This conjugated excitation implies an existence of two zones of sensibility, and there may exist three or even more. These multiple zones sometimes run together to such an extent as to involve the major portion of the tegumentary surface. This is the case in particular with the Glowworm (*Lampyris noctilluca L*) but in this, contrary to what we have observed in the acridians, a single excitation of anyone among them is sufficient to produce immobilization.

The duration of the immobility varies very considerably. It is sometimes closely connected with the excitation and ceases when the later ceases, but it really lasts a considerably longer time without fixing any definite limits; it may be said that its duration varies from one to sixteen minutes. The variations in this duration are as distinct between individuals of the same species as between the individuals of different species. These divergencies, which are sometimes very marked between individuals which are morphologically similar, are of great importance with respect to the interpretation of the phenomenon since they can scarcely be said to furnish any argument in favor of selective action.

Whatever the length of its duration the immobility may be provoked several times consecutively in the same animal. In general the repetition displays no notable change, either in the facility with which the immobility is produced or in the time it lasts. Sometimes, however, at the end of about one hundred excitations it ceases to be produced. However, we must refrain from generalizing upon this point. **Moreover,**

*Translated for the Scientific American Supplement from Rev. Gen. des Sciences.

the study of the prolonged series of excitations gives rise to various observations to which I can refer with more advantage when I have completed my researches along various lines. I will mention one fact only; while among the majority of the arthropods successive excitations produce effects comparable to each other, there are some of them, nevertheless, such as the gilded cetoine, which usually refuse to react to a second excitation after being once immobilized.

At all events the proved fact that there are localized sensitive zones serving as the point of departure for an immobilizing reflex, and the general occurrence of this reflex in the arthropod is sufficient to cast an entirely new light upon the phenomenon which has heretofore been described under the phrase "simulation of death," a third fact adds to the importance of the two former ones: Besides these zones in which immobility is determined by excitation there exist other zones which act as a point of departure for the mobilizing reflex, which is antagonistic to the immobilizing reflex. Like the latter this antagonistic reflex is localized in one or several zones. Its seat varies in individual cases; very frequently and almost generally the excitation of the terminal extremity of the abdomen or that of the tarses caused renewal of motion, but the sensitive zones may have other localizations, and in certain species are even situated in portions which are homologous to those which are the seat in other species of the peripheric localization of the immobilizing reflex, such as the antennae or the root of the wing.

But whatever the seat of the antagonistic sensitive zone may be, its excitation ordinarily produces an immediate irresistible effect; nothing is more characteristic in this respect than the result obtained in the case of the Iulids (Myriapods): If we press the anterior rings of an animal in motion it immediately stops and remains motionless without changing either its attitude or its position; but it again begins to move as soon as we begin to compress the posterior rings. This stopping and starting can be provoked several times in succession without the slightest difficulty.

The phenomenon exhibits itself under a form slightly different, but equally characteristic, in the chrysid hymenoptera, *stilbum splendidum:* If this insect be struck lightly on the head it may displace itself with its thorax against its abdomen and remain several minutes strongly contracted; but if we now seize the root of the wing with pinchers, the body immediately straightens out as if through the operation of mechanical force. During this movement all the appendices of the body remain immovable and press tightly against it; they remain entirely without motion until the body is again straightened out. These experiments show very clearly both the irresistible character of the antagonistic reflex and its peripheric localization. In this way there is definitely proved the existence of limited tegumentary zones which serve as points of departure for immobilizing and mobilizing reflexes.

Immobilization in the Vertebrata: The question arises do these reflexes and other peripheric points of departure exist outside the arthropods. In all probability other animals possess equivalent reflexes. I am able to furnish the proof of this so far as concerns the vertebrata (Batrachians, Birds, Mammals). It must be admitted, to be sure, that the phenomena are not entirely comparable at least in appearance among all of these. Complete similarity indeed could hardly be looked for. Nevertheless the manner in which the batrachians behave presents a striking analogy to that of the arthropods. If, for example, I placed a common frog or a red frog on its back, the animal will turn over; but if while it is in the dorsal position I exert pressure on the median line of its body at the level of the scapular belt, the animal is immobilized for several minutes. I again mobilize it immediately by pressing in the same manner at the level of the pelvic belt: The excitation occasions the adduction of the two posterior parts, then a general torsion of the body, followed by complete renewal of movement. In this case, therefore, I have a definite instance of the immobilizing reflex, and the antagonistic reflex, both of them localized. Perhaps this phenomenon exists in reptiles also, if we may judge by the result of certain maneuvers employed by snake charmers.

In birds and mammals immobilization can be occasioned at will, but without appreciable peripheric excitation and without consecutive immobilization. Moreover, the phenomenon has long been known. In the 17th Century Kircher immobilized fowls merely by turning them upon their backs. The experiment can be successfully made with the greatest ease with any kind of bird; I have performed it with sparrows, with a wryneck and with the finch immediately after their capture, thus excluding all idea of training. The same result can be obtained with various mammals, especially with mice. However, the animal is never entirely immobilized. If it has lost the possibility of moving its members, its eyes remain wide open and follow the course of a finger moved in front of them; in the same way the neck turns from right to left.

What is the cause of this immobilization? At present this seems difficult to say. It does not appear probable, however, that modifying the position of the animal in space is sufficient to paralyze its movements: It is necessary to occasion an excitation of the nervous centers. Various physiological considerations and experiments performed by various investigators lead to the belief that the excitation of these centers may have its point of departure in the internal ear. The displacement of the head and its maintenance in certain positions involved as well attitudes comparable to these which the animal will take after the removal or injury of the semi-circular canals. The friction of the otoliths held in suspension in the endolymph, and pressure by this endolymph upon certain zones of the internal surface of the labyrinth may then perhaps provoke immobilization. It should be recognized, however, that this explanation does not apply to the Batrachians, but only to birds and mammals.

Nature and Mechanism of Immobilization: If the method in which immobilization is caused varies in different groups, do not its nature and its mechanism differ likewise? Between the arthropods and the vertebrata the distance is very great, so that if the immobilizing reflex is found in each, there is nevertheless nothing to prove that it is entirely similar in the two cases. In the first place certain interpretations must be absolutely excluded: Neither in the arthropods nor in the vertebrata can we believe in the paralyzing terror which has become secondarily hereditary, since the reflex is not sensory in either one. Moreover, fear does not manifest itself in this manner, and nothing is more dissimilar to the immobilized animal, extended without resistance in an abandoned attitude, than a mouse or a guinea pig, crouching and trembling, huddled together in the corner of his cage.

We can scarcely accept either voluntary immobility or a ruse. There are certain mammals indeed, such as dogs or monkeys, which appear to be not incapable of a ruse, but we must not generalize here. Moreover, there is a necessary distinction to be made between an animal which *remains immobile* for any reason whatever, and an *immobilized* animal. The two acts, which are both found in the arthropods as well as in the vertebrata, differ essentially from each other. The immobile animal retains its normal relations with external things as was observed by Piéron in 1908; it reacts notably to sensorial excitations, but the immobilized animal has very restricted relations with external things; in particular it does not react, or reacts very slowly to sensorial excitations. The two phenomena, therefore must not be confused; not even a genetic bond between them is to be perceived: Reflex immobilization is most certainly not derived from immobility as was believed by Holmes. Even if we admit that immobility procures some advantage to an animal, this advantage would disappear with the loss of excitability, and especially of visual excitability, since with the loss of that there would vanish all possibility of escaping at an opportune moment. Immobilization in no way constitutes an advantage for the species by permitting it to avoid aggressors, and cannot have been developed by selection. The latter, strictly speaking, could have played a part only if the immobilization had been produced in certain species to the exclusion of others, and if it were produced in these in a similar manner in all individuals. But while the phenomenon is sufficiently general in a large number of species, it is, however, true that a portion of the individuals are readily immobilizable, while another portion are so quite inappreciably: Since selection has not caused the disappearance of the latter individuals, they cannot be inferior to others under the habitual conditions of existence.

Moreover, what real advantage could an animal derive from complete and durable immobility? Naturalists have accepted the hypothesis that the appearance of death would drive away predatory creatures since these do not care for corpses; but this hypothesis does not rest upon any ascertained fact, since on the one hand many animals, far from being repelled by dead flesh, are especially attracted by it; and on the other hand the mere absence of movement is not sufficient to impart to any organism all the properties of a cadaver. In particular the odor is lacking, and this is far more important than the external aspect, so far as predatory animals are concerned.

Furthermore, the existence of an antagonistic reflex, capable of causing an irresistible recommencement of activity, risks the interruption at any moment of this supposedly protected immobility; and this constant possibility notably reduces the degree of "utility" which immobility might be thought to possess; hence, such utility cannot be said to exist in animals which are readily immobilized, and which have so long been thought to "simulate death"; hence, it cannot have taken part in the operation of selection, and not only is it impossible that this property could have preserved the individuals best endowed in this respect, but in fact if the facility of immobilization had intervened in any way at all, it would have involved the disappearance of a very great number of animals for whom the immobilizing reflex constitutes an incontestible danger. When, for an example, an insect which is endowed with very rapid motion is caught by one leg, and immediately finds itself paralyzed and delivered up defenseless to its enemy, one can scarcely deny that the immobilization here constitutes a marked disadvantage. By retaining the possibility of biting or struggling it might sometimes be able to liberate itself and take flight, whereas the immobilizing reflex deprives it of all chance of this.

Immobilization, in fact, whether or not it resembles the immobility of death, fails to play any essential part either useful or injurious in the life of an animal. It is a property of the nervous system very wide spread among the arthropods as well as among the vertebrates, and one which is important to recognize and comprehend.

As to its nature we still possess very incomplete data. Various authorities have spoken of hypnotism, but this term offers no solution, since it, itself, designates a phenomenon which is far from being well understood. Furthermore, immobilization presents itself in wide range as to conditions among different kinds of arthropods and different kinds of vertebrata, such difference being naturally still more marked between these two classes of animals. At the present time we can do nothing more than set forth the features found in common without undertaking to extract from them an explanation which will respond exactly to all cases.

The general characteristic of the immobilized animal is a more or less strongly marked contraction in a certain number of muscles pertaining to its relative life, a durable contraction which persists longer than the excitation; hence, we have here a contraction which is evidently established without previous relaxation and which is apparently due to an exaggeration of the normal muscular tenacity. Sometimes the muscles are so strongly contracted as to resist all effort at traction; if one succeeds in displacing them, they immediately resume the former position as soon as the traction ceases. Sometimes they are but feebly contracted and readily cede to a slight effort, returning but very incompletely to their initial position. Between these two extremes there exist all the intermediate stages, and these intermediate stages are found as well in the homologous muscles of different animals as in the different muscles of the same animal. The immobilization of the bird is very significant in this respect: The contraction of the muscles of the claws is very marked, while that of the extensor and flexer muscles of the neck is very feeble; that of the rotating muscles of the head is medium, while there is none at all in the muscles of the beak and in the eyelids.

This general characteristic being given, we find ourselves impelled to ask whether prolonged muscular contraction does not exist outside the arthropods and the vertebrates. Thus stated, the question doubtless must need to be answered in the affirmative. Casting a general glance over the animal kingdom we immediately perceive that it contains entire groups—collentera, mollusks, tunicians, etc.—composed of individuals which contract under various stimuli and remain contracted long after the external stimulus has disappeared. But though the excitant has disappeared, the excitation must persist, for a durable contraction necessarily involves a continuous excitation. Whence then does this excitation proceed? We are entirely lacking in any positive data with respect to this question, hence we are reduced to hypotheses in an attempt to answer it. We are forced to believe that certain nervous centers act as accumulators of energy, the excitations involving definite peripheric zones, producing considerable quantity of energy which is stored up by the nervous center, and then slowly dissipated towards the muscular fibers. There results from this, in place of a sudden violent and rapid tetanus, a contraction of long duration, and of every degree of intensity. In different animals the various nervous centers do not retain the energy in exactly the same manner, and this is the reason why the duration of the immobilization is so variable. The same explanation applies to the most various kinds of

(*Continued on page 298*)

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Cultivating cotton in California

Picking cotton in the South

King Cotton Has Come Into His Kingdom

A Bumper Crop When Most Needed

Never has the South known such a "cotton year" as the present. This is the first season in history that the South will produce a bumper crop of the famous white staple and at the same time, because of war demands, realize for it maximum prices. Such a combination, previously unknown, has long been a dream of the Southern planter. No wonder the colored folks are singing and that Dixie Land is all smiles. While it is true that in 1866, at the close of the Civil War, cotton brought more than 30 cents a pound, the South, desolated by the war, had only been able to raise a mere 1,750,000 bales. Necessarily the price was high, although at that time cotton was put to few of the purposes it is today except the making of stockings, underwear, and "dress goods." Cotton seed also was then regarded as useless except for planting, and piles of it were dumped out to decay beside gin houses all over the South.

But even at that 31 and 32-cent cotton, for a crop of less than 2,000,000 bales, gave Southern farmers new hope after the long fratricidal struggle. They saw the sun shining once more, and they went out to clean up the fields of weeds and to raise all the cotton they could plant and cultivate.

The result was that in 1867 a crop of 2,340,000 bales was picked and ginned. But the farmers had overshot the meager demand of the reconstruction period. They had grown more cotton than the world needed within a season and the price fell to about 15 cents a pound. Consequently even with a much larger crop than in 1866, the farmers received for the 1867 crop but little more money than they got for the 1866 yield.

From that time to the present cotton growing has been more or less a see-saw game between production on one hand and demand and prices on the other. Good prices one year have stimulated larger plantings the following year. Then the increased acreage the second year has sent prices down. These low prices the second year have discouraged overproduction the third year, with, consequent good prices again owing to increasing demands for cotton in the new uses found for it.

Of course, cotton acreage, despite the above mentioned drawbacks, has steadily been increasing as the demand for the staple has become greater and greater in all the civilized countries, until in 1913 and 1914 the South planted the largest acreages in its history, approximately 37,000,000 acres in each of these seasons. In 1914 the South grew its most gigantic crop—more than 16,000,000 bales.

Even the world war will never erase from the minds of the Southern people the Autumn of 1914—the most depressing period the South has experienced since the Civil War. Those millions of bales of cotton had cost, on an average, 8 cents a pound to produce.

Largely because it was impossible to market the crop on account of freight congestion, U-boats, lack of tonnage, and general war conditions which had halted the manufacturer, cotton dropped to 6, 5, and even 4 cents a pound in some sections, and the South found itself tens of millions of dollars in debt, and with its winter supplies of meat, meal, and dairy products still to be bought from the Central West. And besides, there was no immediate market for several million bales even at 5 or 6 cents a pound. Then began the well-remembered "buy-a-bale" movement. The psychological effect on the nation at large of this bizarre campaign was good, but its practical benefits to the cotton planter were too small to be reckoned as of much value.

Delivering loose cotton at the gin. A Southern scene

The acreage in cotton this year is estimated to be almost as large as that of 1913 and production, it is believed, will very nearly come up to the unprecedented yield of 1914, the Government estimate being for more than 15,000,000 bales.

Conditions however today are utterly different from 1914; our intensive ship building programme has greatly increased tonnage, the U-boats are by no means as dangerous as they were, freight congestion is largely a thing of the past, and finally war industries the world over have need for every pound of cotton that can be put upon the market.

In the early spring the prospects for a large crop of cotton in the South were poor as the weather was exceptionally cold, necessitating a very widespread replanting of the crop. Since then, however, Providence has seemed to reward this persistence by giving the South an almost ideal summer growing season, that is plenty of hot weather and enough but not too much rain.

Texas is probably the only exception. Here, because of a drought, there has been a loss of more than 1,300,000 bales according to conservative estimates.

On June 15th the probable yield of the State was placed at 4,000,000 bales. The latest survey of the yield probably will not exceed 2 700,000 bales.

If cotton was like most crops the planters might just now be passing some very worrying days, as the labor shortage has had its effect on the South as elsewhere, and if the cotton crop had to be gathered in a few days after it was ready for harvest then there would be grave danger that it could not be done this year; but cotton is much kinder to the grower in this particular than most other crops, as the picking season, if needs be, can be extended over the entire fall and well on into the winter.

The harvest of the crop began a few weeks ago, in September, and with the labor at hand the work will continue for the next three or four months, when it is reasonably certain that the entire crop will be harvested.

The only thing, therefore, which has worried the Southern planters this season is the "Boll Weevil," and even this pest has not been a great annoyance, as in the older boll weevil sections the farmers have

Short staple cotton in bloom in Georgia

Bales of cotton on their way to the mills

learned by years of experience how to check this persistent and ravenous pest. In such regions all the magic "cures" for boll weevils, that poured in from home-grown "scientists" and also from far-away chemists who never saw a stalk of cotton, have been found to be worse than useless. "Limited acreage and constant cultivation" is the old remedy and the only one that is effective.

And so, despite the boll weevil, labor shortage and war conditions Dixie will come to the rescue of the world this fall with the largest crop of cotton, save one, that she has yet raised. And the world will give her for this crop more money than it has ever paid for the cotton yield of any season. If spot cotton remains close to 30 cents a pound for middling the South's baled cotton, as is expected, this year will bring more than $2,250,000,000. There will, in addition, be at least a million bales of linters, and these, at the fixed price of 4.67 cents a pound, will bring at least $23,000,000.

In ginning this year's cotton crop about 7,000,000 tons of seed, it is said, will be obtained. It is quite probable that 80 per cent. of this yield will be marketed.

There is some dissatisfaction on the part of the cotton growers over the low price which some cotton seed oil manufacturers and dealers are so far offering for seed. In some localities as low as $50 per ton.

In Texas the State Department of Agriculture has been urging that a minimum price of $70 per ton be fixed for the product but the indications are that about $55 or $60 per ton will be paid.

On account of the arguments in reference to price the growers have been holding back in the selling of the seed, although the Government is anxious that it be marketed as promptly as possible by the farmers, and handled without delay by the mills, as the linters obtained therefrom are badly needed for the making of high explosives and munitions.

If the seed is sold at around $60 a ton, and 80 per cent. is marketed, it will bring to Southern farmers more than $300,000,000 alone, while the total receipts for the entire cotton crop will, figuring on the basis of 30 cents per pound, probably be close to $2,600,000,000.

No wonder the colored folks are singing and that Dixie is now all smiles and that the cotton warehouses, half empty since 1915, are all ready to again store vast white wealth and that the gins, many of which have been almost out of commission for the past three years, have been equipped and oiled anew for the ginning which is now proceeding.

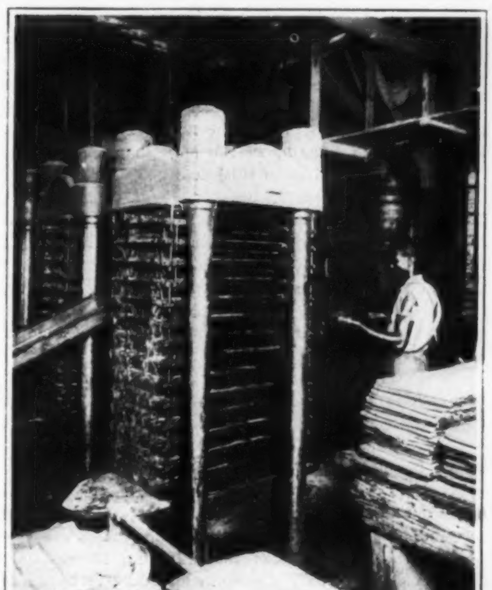
Meanwhile, to prevent all loss, as far as possible, the Bureau of Chemistry and Bureau of Markets of the United States Department of Agriculture are investigating, from headquarters at Dallas, the causes and methods of preventing fires in cotton gins. Nearly 400 fires occurred in Texas cotton gins alone last year, with an estimated loss of cotton worth a million dollars.

The history of cotton, which has reached its zenith of importance this year, stretches back into prehistoric times, as it is one of the oldest of all the staple articles of commerce. When or where it was first manufactured is uncertain, but long before our advent in the market India and other nations of the Far East had a world wide fame for its cultivation and manipulation; cotton spinning was wonderfully developed by English inventors in the 18th century, and British laws sought by severe penalties to prevent the knowledge of these inventions from being conveyed to other countries.

Since Slater brought the designs of improved English machinery for cotton manufacture in his brain to America, the development of that industry has been gigantic. By 1902 the United States had one-fourth of all the cotton spindles of the world, and was consuming nearly one-third of the world's products of cotton.

The importance of our cotton crop in the world's affairs is well illustrated by what has happened when cotton famines have occurred.

When on account of the outbreak of our Civil War the cotton supply failed, because of the blockade of the Southern ports, the mill owners of Lancashire, England, the world great cotton center at that time, finally closed their mills, and nearly 2,000,000 people were reduced to such great distress that Parliament was



Pressing cotton seed to extract the oil, now a valuable product

obliged to grant loans to the guardians of the poor for the purpose of instituting relief work.

In 1903 again serious want and destitution was caused in many British textile centers, and to a lesser degree in some American manufacturing towns, by the

Cakes of cottonseed after pressing and extracting the oil. These are ground for cattle food and fertilizer

comparative scarcity and high price of cotton. What happened in 1914, when the world's war brought distress to the cotton market, has already been told in this article.

Crossed Nerve-Paths Explained

There is no fact with which medical men are more familiar than that the nerve-tracts which connect the brain and body are crossed, the right half of the body being united to the left hemisphere of the cerebrum and the left half to the right hemisphere. In 1907 Prof. A. Francis Dixon, Trinity College, Dublin, sought to explain the crossed arrangement by supposing that it was a result of the primary connection between the right halves of the retinae with the right hemisphere of the cerebrum. The right halves of the retinae receive rays coming from the left field of vision—the field in which the left half of the body is situated. Prof. Dixon pointed out that there is a manifest functional advantage in having the part of the brain which controls the movements of a limb situated near the cerebral area which receives the visual field in which the limb is situated. To secure that end, the nerve paths have to be crossed, so that the hemisphere which receives the left visual field will also control the left half of the body. In the Dublin *Journal of Medical Science* (March, 1918), Prof. Dixon has carried his explanation a stage further—an extension due to the discovery by Col. W. T. Lister and Lieut.-Col. Gordon Holmes that the retinal picture is inverted in the visual cortex of the brain, the upper half of the field of vision falling on the lower half of the visual cortex. It is well known that the movements of the body are represented in an inverted order in the cortex of the brain, those for the mouth and face being placed lowest down, and those for the lower limb higher up. If the retinal connections are the circumstances which determine the distribution of cortical areas, as Prof. Dixon supposes, the visual fields being inverted in the cortex of the occipital lobes, then we should expect, just as we actually find to be the case, a corresponding inversion of the motor areas—the movements of those parts of the body which lie in the upper field of vision being lowest down on the surface of the brain, and those in the lower visual field highest up.—*Nature.*

Co-ordination of Chemical Abstracts in Germany

The issue of the *Berichte der Deutschen Chemischen Gesellschaft* for April 13th, 1918, contains the text of a agreement arrived at between the Deutsche Chemische Gesellschaft and the Verein Deutscher Chemiker concerning the joint publication of abstracts. It provides for the discontinuance of the "Referate" section of the *Zeitschrift fur angewandte Chemie*, and for the enlargement of the "Technischer Teil" of the *Chemisches Zentralblatt*. The latter is to be prepared and edited, as previously, by the German Chemical Society, but the Verein will pay an annual contribution of 25,000 marks toward the cost. Subscriptions of the two societies are to be arranged according to the publications desired by the members. The Verein is to pay the costs of printing, paper, and binding for the copies of the "Technischer Teil" of the *Zentralblatt* required by its members, and undertakes the despatch of these copies to them. The *Zentralblatt* will be divided into a "Wissenschaftlicher Teil" and a "Technischer Teil," the former comprising sections on general and physical chemistry, inorganic, organic, physiological, medicinal, mineralogical and geological chemistry, and bibliography; and the latter, sections on apparatus, analytical chemistry, technical chemistry and patents. With regard to borderland subjects, it is provided that abstracts on fermentation chemistry, with the exception of those of purely physiological interest (foods, soils and ferilizers, and most of those on pharmaceutical chemistry), shall be included in the technical part, and abstracts on bacteriology, most of those on hygiene, and those on agricultural chemistry of a physiological character, in the scientific part of the *Zentralblatt.*

The agreement includes provisions in regard to the settlement of difficulties, to arbitration, and to the sale of the *Zentralblatt* to non-members and to booksellers. Subject to confirmation by general meetings of the two societies, the agreement will take effect from January 1st, 1919, for a period of 10 years.

The Principal Bridges of the World—II*

A Comparison of Their Size, Importance and Principles of Design

[Concluded from Scientific American Supplement No. 2235, Page 288, November 2, 1919]

Suspension Bridges

The advantage of the suspension type of bridge is that it can be erected almost entirely without falsework, although it must be remembered that some of the cantilever and arch types also require but very little scaffolding or temporary work in their erection.

The flexibility so noticeable in the earlier bridges of this class is now greatly diminished by the use of stiffening trusses suspended from the cables, the theory of which has greatly developed in recent times. But generally, if any other type than the suspension bridge can be built as economically, it is generally preferable to adopt another type which would be more rigid and better able to resist wind pressure and moving loads.

Brooklyn Bridge.—The old Brooklyn suspension bridge, crossing the East River between New York and Brooklyn, was for many years the most prominent object in this part of the United States, but now there are three large structures across the same river, the Brooklyn, the Williamsburg, and the Manhattan suspension bridges. The Williamsburg bridge has a span of 1600 ft., a length greater only by 4 ft. 6 in. than the Brooklyn bridge. The two stiffening trusses in the Williamsburg bridge are 40 ft. in depth and 72 ft. apart on centers, and the bridge is said to have the largest traffic of any bridge in existence, having provision for four trolley roads, two elevated tracks, two footwalks and two carriageways on projecting brackets, and the length of span is only surpassed by the Forth bridge in Scotland, 1710 ft., and by the Quebec bridge with its 1800 ft. span.

The period of the erection of the Brooklyn bridge was from 1869 to 1883. The towers are 1595 ft. 6 in. on centres, and outside the main span are two half or end spans, each of 930 ft. length. The approach on the New York side is 1562 ft. in length, and on the Brooklyn side 971 ft., making a total length of viaduct 5989 ft. The bridge carries across the river two elevated railway lines, two trolley tracks on two 18 ft. highways, and a central footpath of 15 ft., the total width of the bridge being 85 ft. The sag of the four main cables amounts to 128 ft., and each cable is 15¾ in. diameter. The clearance from the water is 135 ft.

The Manhattan Suspension Bridge is situated about one-fourth of a mile to the east of the first Brooklyn bridge, and is said to have the greatest carrying capacity of any bridge in existence. There are two decks to the bridge, the lower deck having provision for four surface tracks, one 35 ft. carriageway, and two 11 ft. footpaths, and the upper deck have provision for four elevated railway tracks. The total width of the bridge is 120 ft. The structure was opened in 1909.

The design originally provided stiffened eyebar chain cables for the main suspension members, but this plan was altered to wire cables having a diameter of 21¼ in., which hang in vertical planes from the top of the towers. The spans are 1470 ft. in the centre, with two side or half spans of 725 ft. each. There are efficient stiffening trusses, and the suspenders in this case are vertical.

The Sarine Valley Suspension Bridge at Fribourg, in Switzerland, was for several years the longest bridge of the type in Europe. It was erected in 1834, and originally had four main cables, each made up of 1056 wires, two cables on each side of the roadway. It carries a roadway 15 ft. in width and two side paths each 3 ft. wide, giving a total width of 21 feet.

The central span is 870 ft. in length and the cables have a central sag of 63 ft., the floor being 167 ft. above the valley. The cables are anchored into the rock on each abutment, tunnels being made to each anchor chamber. The wooden floor beams are suspended from the cables by vertical rods or wires 1 in. in diameter.

In 1880 an additional cable was placed at each side of the bridge to strengthen it. It is said that when the bridge was tested by 15 guns, 50 horses and 300 people, the deflection amounted to 39 in.

Niagara Suspension Bridge.—The suspension bridge over the Niagara River, just below the Falls, was completed in 1855 for the Grand Trunk Railway. It was double-decked and carried a 15 ft. carriageway below the railway. The stiffening side trusses were made of wood and were open webbed and fairly deep. It was expected that the lower floor would stiffen the structure, but it was found not to aid the top chord to the required extent; the upper chords were overstrained and the lower chords were working loose. Auxiliary timbers were bolted to the underside of the floor, and in 1877 the anchorage chains were strengthened. In 1880 the trusses were renewed in iron, the work being begun from the centre and carried outward piece by piece until the ends were reached.

This bridge was superseded in 1897 by a steel arch bridge of 550 ft. central span and two side spans of 115 ft. each, the old suspension bridge being used as far as possible during the erection of the new steel bridge.

Lewiston Bridge, Niagara.—Another bridge across the Niagara gorge is the Lewiston suspension span, two miles below the Falls. The length of the supported floor is 850 ft., and the width 21 ft., but the towers supporting the cables are 1040 ft. apart, the cables having a sag of 87 ft. It was built in 1850, but while the guy cables had been temporarily removed in 1861, the bridge was wrecked by a storm of wind.

Nothing was done until 1899, when a new bridge was built to carry a highway with a line of electric cars in the middle, and this bridge, the ninth across the gorge in this district, remains as the only suspension bridge over the Niagara River at this locality.

The cables are four in number, 10 in. diameter, and guy ropes are placed to resist wind pressure, which is liable to be uplifting. The main cables were brought from superseded suspension bridges further up the river and re-erected at Lewiston. The steel stiffening trusses are 800 ft. in length, 14 ft. in depth, and 28 ft. apart on centres, and the towers stand on rocky cliffs high above the roadway.

The Point Bridge at Pittsburgh was built in 1876, and carries a 20 ft. roadway and two footpaths 7 ft. wide, across a centre suspension span of 800 ft. and two side spans of 145 ft. each, the total length of the bridge being 1250 ft., and the clear height above the water 80 ft. The cables or chains are eyebars, and have stiffening trusses with straight top chords above the chains, so designed that all uniform loads are carried by the chains alone, the stiffening trusses only acting when unequally distributed loading is upon the bridge. The eyebars are 8 in. in width.

East Liverpool Bridge, Ohio.—The suspension bridge over the Ohio River at East Liverpool, Ohio, consists of a central span of 705 ft. and two side spans of 360 ft. and 420 ft. long respectively, giving an overall length of 1485 ft. This bridge again, as in the case of the Point bridge, carries a 20 ft. roadway, but has only one footpath 7 ft. in width. The stiffening trusses in this case are 20 ft. deep, and the bridge has a clearance above the water of 90 ft.

Roche-Bernard Bridge.—The wire suspension bridge at Roche-Bernard, in France, has a great resemblance in its general outline to the Menai bridge across the Straits, near Bangor, Wales; but while the French example has a span of 650 ft., the length of the large span of the Welsh bridge is 580 ft. The arches at the ends of the spans are similar in design, although they are not of the same span in both cases. The Roche-Bernard bridge is over the Velaine River, and has a clearance of 110 ft. above the water. There are four wire cables, having a sag of 50 ft. It was wrecked by a storm in 1852, and when the span was restored counter cables were added to it.

The end cables leading down from the tops of the towers to the anchorages are not loaded except from the central span, and the cables have the same inclination on both sides of the towers.

Cubzac Bridge, Dordogne.—The bridge over the River Dordogne, at Cubzac, was built in 1839, and has five equal spans of 357 ft. each, making an overall length of 1785 ft. in the suspended spans. It is remarkable for the number of spans all of the suspension type, for it is very unusual to have suspension bridges in such a series, and for the way in which bracing is carried from the top of each tower to the bottom of the adjoining towers on each side.

The Loschwitz Bridge, near Dresden, with its central span of 481 ft., and two side spans of 202 ft. each, has an overall length of 885 ft., and is certainly remarkable for its rigidity. By the system of web bracing adopted, practically forming stiff spandrils on each side of the towers, it appears doubtful whether this bridge should not be included in the cantilever class of bridge. The width of the platform is 36 ft., and the structure is said to be strong enough for a double line of railway. The curve of the upper chord is a hyperbola. There is a hinge in the center of the span which is able to transmit tension from one half span to the other, and thus the bridge may be termed a three-hinged suspension structure.

At one time, if not at present, this bridge was remarkable on account of its being kept painted a bright cobalt blue.

The Grand-avenue Suspension Bridge at St. Louis carries a street over a railway yard, the centre span having a length of 400 ft. and two end spans having a length of 150 ft. each. It was completed in 1891. In this case the suspension cable has developed into an inverted arch with three hinges. The upper chords and all web members are formed of eyebars, and it was intended that all uniform loads should be carried by the top chord. The lower chord, on the other hand, is made up of light riveted sections, and was intended for stiffening purposes only. The main suspension frames are 42 ft. apart, and support a 60 ft. width of floor.

Menai and Conway Bridges.—Perhaps for the purpose of comparison, a reference may be made to the well-known Menai and Conway suspension bridges in this country, both of which were completed in 1826. The Menai bridge has a central span of 580 ft. and carries two 12 ft. carriage drives with a footpath 4 ft. wide between them, at an elevation of 120 ft. above low water. There are 16 main cables, with a versed sine of 43 ft., arranged in four sets, two sets on each side of the roadways. Each of the sets has four chains vertically over each other. Each chain contains five iron bars, 3¼ in. by 1 in., 10 ft. long, the total cross sectional area of the main chains being 260 sq. in.

The Conway bridge has a span of 327 ft., and the sag of the chains is 22 ft. The chains originally consisted of four eyebar links on each side, 3½ in. by 1 in., and 9 ft. long, the four links on each side being vertically over one another, but not connected, and anchored back into the solid rock. After 80 years existence in this form, the bridge was strengthened in 1904 by two new wire cables on each side, new suspension links, and stiffening girders 8 ft. 6 in. in depth. A new 6 ft. path was also added.

The Hungerford Footbridge across the Thames at Charing Cross, built in 1845, had a span of 676 ft., with a versed sine of 50 ft., two side spans of 329 ft. each, and a width of 14 ft. The four main chains, two on each side, were composed of 7 in. by 1 in. links, 24 ft. long.

This bridge was removed to make room for the new Charing Cross railway bridge, and was re-erected at Clifton, near Bristol, in 1863, with a span of 702 ft., and height of 252 ft., above the river Avon below. It has now six chains, three on each side, and the width of the platform is 31 ft.

*The Engineer.

Influence of Carbon Monoxide on the Velocity of Catalytic Hydrogenation of Oils

Especial interest attaches to the effect of carbon monoxide on the catalytic hydrogenation of oils, owing to the fact that hydrogen prepared commercially from water-gas usually contains a small amount of carbon monoxide. In the experiments described, pure neutral olive oil was hydrogenated in a vessel which was mechanically agitated in an oil-bath maintained at 180 degrees C. The hydrogenation vessel was charged with 10 grms. of the oil and a catalyst containing 0.1 grm. of nickel, and, after being exhausted by means of a Geryk pump, in successive experiments pure hydrogen and hydrogen containing from 0.25 to 2.0 per cent of pure carbon monoxide respectively were admitted and the amounts of absorption were measured by reading the volumes of gas left in burettes connected with the hydrogenation vessel. It was found that when the hydrogen contained as little as 0.25 per cent of carbon monoxide, hydrogenation for several hours was necessary to introduce into the oil the same volume of gas as was absorbed in one hour in the case of pure hydrogen. The first traces of carbon monoxide are relatively the most poisonous, and the inhibitive effect of successive increases in the proportion of carbon monoxide decreases with the rise in the proportion. The toxic action of carbon monoxide may be distinguished from the diluting action of any foreign gas which merely obstructs the hydrogenation.—*Note in J. Soc. Chem. Ind. on a paper by E. B. Maxted before the Faraday Society.*

A Study of Percentage Solutions*[1]

By Prof. Theodore J. Bradley, Dean of the Massachusetts College of Pharmacy

A paper entitled "A Study of Some Percentage Solutions" was read by the author at the Indianapolis meeting of the American Pharmaceutical Association and was published in the November, 1917, issue of the *Journal* of the association. A spirited discussion followed the reading of the paper and the interest shown has led to further consideration and investigation of the subject, with results embodied in this second paper, in which certain parts of the first paper are repeated for the sake of clarity.

In general, it is impossible to prepare a pre-determined volume of a solution of a definite percentage strength, as we cannot know the specific gravity of the solution before it is made, and it is contrary to American custom to prescribe or dispense liquids by weight, though correct precentage solutions can easily be made if the solvent is weighed as well as the solid constituents of a solution. "Percentage solution" means that the given number of parts by weight of the chemical are contained in 100 parts by weight of the solution, but many dispensers who have calls for a fluidounce of a percentage solution will calculate the required percentage of 480 grains, assuming that this is the weight of the finished solution, which is seldom quite true. Others will calculate the required percentage of 455, or thereabouts, assuming that the finished solution weighs the same as one fluidounce of water, which is never the case. Either of these men will weigh the calculated amount of the chemical, introduce it into a graduate or an ounce bottle and add sufficient of the solvent to make one fluidounce, thus making what is called a "weight to volume" solution.

VARIATION IN STRONG SOLUTIONS.

Remembering that it is practically impossible to make an absolutely accurate solution of any strength, these methods are sufficiently accurate for weak solutions, say up to 5 per cent. strength, perhaps even up to 10 per cent. strength, but such methods will not do for strong solutions, the specific gravities of which are markedly greater than that of water. In various parts of the country strong solutions of silver nitrate, potassium iodide, and other chemicals are frequently prescribed, but the druggist who is asked for a 50 per cent. solution and weighs 240 grains of the chemical, adding enough water to make a fluidounce, will dispense a solution of about 35 per cent. strength. If the physician calls for a percentage solution, it is not safe or wise to assume that he means a weight to volume solution as in the foregoing example.

In all essential ways the problem is the same for metric quantities, although the fact that a fluidounce of water does not weigh an apothecary's ounce, somewhat complicates the matter when common quantities are used.

An indefinite volume of a correct percentage solution can be made by dissolving as many parts of the chemical as the percentage requires in sufficient water to make 100 parts by weight of the solution, and this method may be used to prepare a volume greater than any given number of fluidounces, as in the following example:

To dispense 2 fluidounces of a 25 per cent. solution of silver nitrate.

100—25=75 parts of water in 100 parts of the solution.

455×2=910 grains, weight of two fluidounces of water.

75: 25:: 910:x=303 grains, weight of silver nitrate to be added to 2 fluidounces of water.

(Notice that 2 fluidounces of water are to be used, *not* enough water to make 2 fluidounces.)

While this method is accurate, it is wasteful, as the surplus is generally thrown away, or it is impracticable in requiring the preparation of unstable stock solutions.

The varying practices of pharmacists in dispensing percentage solutions are well known, and the investigation was originally undertaken to ascertain how nearly the correct percentage solutions of some important kinds of chemicals compare with the solutions made by different methods and dispensed as percentage solutions: in other words, to ascertain whether the differences are considerable, or so slight as to be within allowable degrees of error. Also, if possible, to work out simple methods for preparing correct percentage solutions when they are necessary.

Correct percentage solutions of silver nitrate and of cocaine hydrochloride, both of which are often dispensed in percentage solutions, were made and their specific gravities determined, and from the results the following tables were constructed:

PERCENTAGE SOLUTIONS OF SILVER NITRATE.

Strength	Specific gravity at 25° C.	Weight of 1 fl.-oz at 25° C. in grains	Grains of the salt in 1 fl.-oz.
0 per cent.	1.000	454.6	0.0
1 per cent.	1.009	458.7	4.6
2 per cent.	1.017	462.0	9.2
3 per cent.	1.025	466.0	14.0
4 per cent.	1.034	470.0	18.8
5 per cent.	1.043	474.1	23.7
6 per cent.	1.052	478.2	28.7
8 per cent.	1.071	486.9	39.0
10 per cent.	1.096	498.2	49.8
12 per cent.	1.128	512.8	61.5
15 per cent.	1.162	528.2	79.2
20 per cent.	1.216	552.8	110.6
25 per cent.	1.276	580.1	145.0
50 per cent.	1.688	768.4	393.2

The quantities in the last column may be used for preparing correct percentage solutions of silver nitrate by multiplying the number of grains in one fluidounce of any given strength by the required number of fluidounces of the solution, and dissolving the resulting number of grains of the salt in sufficient distilled water to make the required volume. Thus to prepare 2 fluidounces of a 25 per cent. solution of silver nitrate:

145×2=290 grains of silver nitrate, to be dissolved in sufficient water to make 2 fluidounces of the solution.

PERCENTAGE SOLUTIONS OF COCAINE HYDROCHLORIDE.

Strength	Specific gravity at 25° C.	Weight of 1 fl.-oz at 25° C. in grains	Grains of the salt in 1 fl.-oz.
0 per cent.	1.000	454.6	0.0
1 per cent.	1.003	456.0	4.6
2 per cent.	1.005	456.9	9.1
3 per cent.	1.007	457.8	13.7
4 per cent.	1.009	458.7	18.3
5 per cent.	1.012	460.1	23.0
6 per cent.	1.015	461.4	27.7
8 per cent.	1.020	463.7	37.1
10 per cent.	1.025	466.0	46.6

LITTLE DIFFERENCE IN WEAK SOLUTIONS.

The most important thing in these tables is the fact that the convenient methods commonly used for making weight to volume solutions when percentage solutions are called for give substantially correct results in solutions up to about 10 per cent. in strength. Solutions made on a basis of 455 grains to the ounce are all slightly too weak, while solutions made on a basis of 480 grains to the ounce are nearly all slightly too strong, but these differences are of but little consequence. It is only in the stronger solutions of heavy chemicals that the differences are great enough to be important. A 25 weight to volume solution of silver nitrate contains 120 grains of the salt in a fluidounce, while a 25 per cent. solution contains 145 grains in a fluidounce. Similarly a 50 weight to volume solution of this salt would contain 240 grains in a fluidounce, instead of hte 393 grains contained in a fluidounce of a 50 per cent. solution. These differences are too great to be disregarded in these days when medicine is becoming more and more exact in its practices.

Various arguments are advanced for the dispensing of weight to volume solutions when percentage solutions are called for, but these do not hold when examined carefully. Thus, it is said by some to be the common practice to dispense percentage solutions in this way, and that this justifies the method. This can not be so when it is known that a large proportion of pharmacists try to dispense correct percentage solutions. After the original paper was read at Indianapolis and the matter had been thoroughly discussed, the men in the room were asked to indicate the method they used. There were forty or fifty present from all parts of the country, approximately half of them stating that they dispensed correct percentage solutions, while the other half dispensed weight to volume solutions.

Another argument advanced is that doses of medicines in solutions are calculated in volumes of the solutions, but this is not true of the most important percentage solutions called for, namely, those of silver nitrate and of cocaine hydrochloride, both of which are used externally so that the question of doses does not have any part in their consideration.

WHAT THE DOCTOR ORDERS.

It is claimed by some that physicians are thinking of weight to volume solutions when they prescribe percentage solutions, but it is unwise and unsafe for pharmacists to assume that a physician means one thing when his written order calls for another. If the physician means a weight to volume solution when he calls for a 50 per cent. solution of potassium iodide, he should prescribe that one-half ounce of potassium iodide be dissolved in sufficient water to make one fluidounce of solution. If he does not do this, it is not the duty of the pharmacist to dispense anything but what is called for on the written order.

The silver salts used in strong percentage solutions are high in price, and it would appear to some that a pharmacist's use of the weight to volume instead of the percentage method may be for financial gain. In one case reported, two pharmacists filled the same prescription calling for a 25 per cent. solution of a silver salt. One pharmacist prepared it correctly and the other made a weight to volume solution. Naturally, there was a considerable difference in the price charged, and there was an investigation of the matter and considerable embarrassing publicity for the second dispenser.

PHARMACOPOEIAL SPECIFICATIONS.

The strengths of many solutions are given in percentage in the United States Pharmacopœia, and this always means parts by *weight* in 100 parts by *weight* of the solution, unless something else is clearly specified. Thus the statement that hydrochloride acid is "An aqueous solution containing not less than 31 per cent. nor more than 33 per cent. of HCl" unquestionably means percentage by weight, though this is not specified. In case percentage by volume is given, this is carefully specified as in alcohol, which is defined as "A liquid containing not less than 92.3 per cent. by weight or 94.9 per cent. by volume, at 15.56° C." In this case percentage by weight is specified for emphasis, to distinguish it from percentage by volume. But "percenatge by volume" means parts by *volume* in 100 parts by *volume* of the solution, not parts by *weight* in 100 parts by *volume*. In official preparations whose strengths are expressed as *weight* to volume, as in tincture of iodine and syrup of hydriodic acid, the word percentage is not used at all in defining the strengths, which are given in grammes in 100 mills.

The so-called 100 per cent. solution of potassium iodide, sometimes prescribed, and which is made by dissolving one ounce of the salt in enough water to make one fluidounce of solution is a weight to volume solution, but the fact that some physicians loosely call this a percentage solution does not make it one. The author has no objection to weight to volume solutions when they are prescribed, or when they can properly be dispensed as substantially the same as percentage solutions, and he has no wish to be classed as one who is trying to reform a practice that does not need reforming. His only object is to help clear up and standardize a method that seems to need such improvement. The fact that some pharmacists dispense these solutions in one way and some pharmacists is another has led to serious embarrassment in more than one case, and it is plain that our duty is to dispense what is called for. If the physician sometimes means one thing and writes another, that is his responsibility, not ours. [?]

The facts should not be overlooked that percentage and weight to volume solutions are substantially the same up to about 10 per cent. in strength. This is the most important thing shown as a result of this investigation.

The Druggists Circular.

[1] "Percentage solution" means that the given number of parts by weight of the chemical are contained in 100 parts by weight of the solution, but many dispensers who have calls for a fluidounce of a percentage of 480 grains, assuming that this is the weight of the finished solution, which is seldom quite true. Others will calculate the required percentage of 455, or thereabouts, assuming that the finished solution weighs the same as one fluidounce of water, which is never the case.

Experiments on the Manifestation of Osmotic Pressure with Membranes of Chemically Inert Materials

The authors communicate the results of experiments carried out with septa of silica, amorphous carbon, graphite, copper, silver and gold and solutions of cane-sugar. The septa were prepared by compressing powders of the various materials, and by clogging the pores. It was found that when the pore diameters were below a certain value, differing in the case of the different septa, osmotic effects were obtained, and the magnitude of the osmotic effects increases with a decrease in the diameters of the pores of the septa. In this way it has been demonstrated that osmotic pressure can be produced through the agency of capillary forces alone without the aid of solution processes or chemical reactions. The authors discuss the different views which have been expressed as to the mechanism of osmosis, and point out that it is probably a mistake to think that the mechanism is the same in all cases.—*Note from Sci. Absts. on an article by S. L. Bigelow and C. S. Robinson in J. Phys. Chem.*

Dutch army dogs drawing machine guns on a dyke in Holland

A Study of Dogs as Carriers and Draught Animals*

In Military and Civil Service

By P. Hachet-Souplet, Director of Zoological Psychology, Paris Institute

We have made an experimental study of the employment of dogs as draught animals and carriers, in the first instance from a military point of view at the instance of the Minister of War, who had commissioned the Association for the Training of War Dogs to organize sections for canine traction of machine guns, and subsequently from the civil point of view at the request of the Society for the Protection of Animals. We have received a large number of reports from officers in the Army to whom these canine teams have been sent; and for the last three years all the minor freight traffic necessitated by various military and civil requirements have been executed by dogs under our direct observation. Without undertaking a complete and definite theory of canine traction, we believe ourselves competent to formulate a series of precise conclusions and able to demonstrate the practical and humanitarian limits within which dogs can be employed as motor power.

I.—The Respiratory Functions of the Dog and His Proper Equipment

Most of the writers who have considered the question with which we are here concerned, that of the "logical harnessing" of a dog, have regarded the matter as merely a case of fitting the harness of the horse as well as possible to the dog. This was always the aim of the Belgians, who exhibited great pride in the pretty little harness mounted with copper, which they made use of in exhibitions. Doubtless such a form of harness is far better than obliging the animal to drag a load merely by a rope fastened to an ordinary collar, according to the barbarous custom of our Parisian rag pickers! However, the anatomy of the dog and his physiological powers of resistance are quite different from those of the horse!

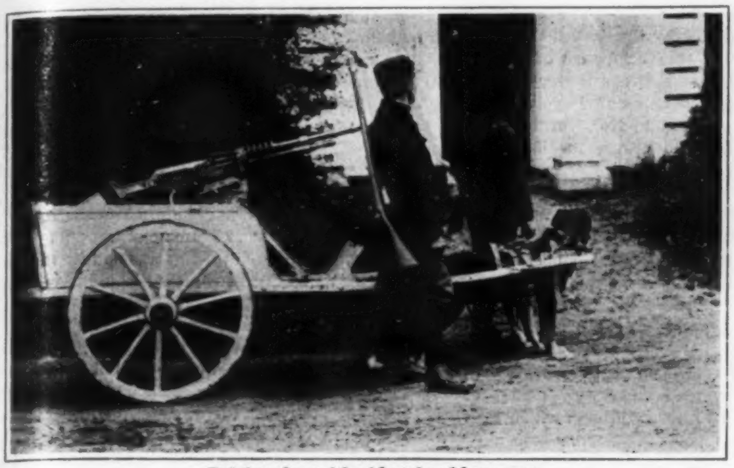
A horse collar is ill-adapted to the use of a dog and rapidly wounds the animal. The shoulder blade of the Equidae forms a long and strong projection, a sort of cornice, and by reason of the fact that it projects very low in front with respect to the vertebrae of the neck, affords an excellent support for the collar; and the neck, which extending obliquely upward, issues from the padded oval without being irritated. But the same form of collar (made in proper proportion) is ill suited to the corresponding portions of the skeleton of the dog; and the dog's neck being almost horizontal during the act of traction, it is forcibly crushed against the lower edge of the collar, hence the windpipe is necessarily compressed.

The breast plate of the horse made of flexible leather is no better suited to the dog; since it exactly fits the form of the chest, one is led to believe that it cannot irritate the skin; but this is an error. The fact is that in the act of inhalation, the thoracic cavity of the dog increases in size on each side; this is due to the lifting of the lateral walls. But the effort expended in traction tends to elongate the flexible breast plate and consequently to bring the lateral portions closer together; these therefore contract like a vise and crush the ribs. Moreover, the respiration is shockingly interfered with. The horse, thanks to his strong bony structure and his muscular power, supports this compression without much suffering; but the dog thus harnessed soon begins to pant and let his tongue hang out. Evidently, therefore, so serious an inconvenience as this must be obviated by giving protection to the ribs.

A correct harness may consist of a breast plate having a rigid metallic frame, padded inside, and composed

An Italian dog train hauling supplies to the front

*From *Revue Generale des Sciences*.



Belgian dog with old style of harness

A dog-drawn ambulance with improved harness

of an aluminum band passing in front of the chest and bearing the straps to which the traces are attached, and another aluminum band passing over the shoulders and holding the first one in place. This apparatus consists approximately of two metal semi-circles perpendicular to each other. Since this light frame work is rigid it cannot contract upon the chest during the effort of traction. Another device which can be employed is a trace separator made of a small arch which is merely added to the ordinary flexible breast plate. It is placed over the shoulders of the animal, being attached on each side of the breast strap and thus easily holding the traces apart.

Another mode of harness consists in placing the dog, provided with a flexible breast plate beneath an iron semi-circular frame to the two branches of which the breast plate is fastened by various straps. This metallic arch is analogous of that of the Russian troïka, except that it is placed beneath the pole and is attached thereto by a bolt, forming a pivot. The animal thus enjoys a great deal of liberty, and the two branches of the arch maintain the separation of the breast plate at the level of the ribs.

II.—THE GAIT OF THE DOG, THE SHAFTS AND THE POLE

The dog has a tendency to undulate when walking. He executes what Darwin has called his "flexuous movements," especially when he is young and running rapidly. At a lively gait he also has a tendency to "cross himself," i. e., the tracks of his hind legs are not in the same line as those of the fore legs. That is why shafts like those of the horse, enclosing his body between two parallel planes close together, greatly annoy him. This fact has long been known to the Belgians. The first article of the regulations adopted several years before the war by the Communal Council of Antwerp, ran in fact as follows: "It is forbidden to harness dogs between shafts." This is why the inhabitants of Antwerp attach their draft animal to the axle beneath the cart; the Germans do the same thing in many localities; but this has the effect of depriving the animal of the main direction of the cart, and it is necessary for the driver to walk between the shafts instead.

Military dispatch dogs

For this reason an effort has been made to devise other methods. We have just described, apropos of the systems of harness which serve to maintain the separation of the breast plate and the traces, a jointed arch which recalls the Russian troïka; but this system may take the place of horizontal shafts; it constitutes a sort of vertical shafts. Another convenient arrangement is that of the jointed pole. This consists either of a wooden pole or a steel tube, which passes over the back of the dog and is attached by its free end to the upper band (forming a back piece) of the rigid breast plate which we have described. The fastening is constituted by a double joint; a first piece permits the movement of the breast plate, and consequently of the body of the dog in the vertical plane, thus leaving the animal entirely free either to sit down or to lie down. This piece is itself placed upon a horizontal pivot which permits all the lateral movements. These movements are limited in fact only by the traces which allow a comparatively great latitude to the shafts. In certain places the traces may be suppressed completely. The draft is then through the pole itself and the play of the whiffletree is replaced by that of the pivot of the back piece. This method of draft is evidently less direct than that which makes use of traces, but the liberty which it confers upon the dog, which is attached to the cart only by a pivot, is a compensation of great value, and the fact is that dogs employed under these conditions show great efficiency.

Machine gun carriages in which the traces have been suppressed have often traveled fifty kilometers a day over rough earth without the dogs exhibiting fatigue.

III.—THE WITHERS AND THE FEET OF THE DOG

We have made a special study of the shoulders of the dog. Many people have advanced the theory that the withers of the dog are not sufficiently strong to balance a two wheeled cart or to support the load of a pack saddle; but experiment has proved the exact contrary of this to be the truth. One may gain an idea of the surprising resistance of the shoulders of the dog from the proved fact that an animal of average size, a harrier for example, can support the weight of a man for several minutes, while standing still of course, and that two dogs yoked together and saddled can carry a man weighing 75 kilograms (165 lbs.) a distance of several hundred meters. It is true that they advance very slowly and painfully, but on level ground they rarely fail to emerge victoriously from the test.

And now let us consider whether the limbs of the dog are suited for traction. This animal is a digitigrade runner; its joints, though much more supple than those of the horse, act however almost exclusively in planes parallel to the general direction of progress: *a priori* it may be said that they rarely suffer from sprains; in fact they almost never show signs of strain. Thus far indeed I have observed none at all. As for the elastic pads on the bottom of the foot in marching dogs, they resist the longest marches, even over pebbles. The harrier has proved this by covering vast distances at full gallop. An ointment made of tallow and lampblack is excellent to keep the bottom of the foot in good condition.

IV.—TRAINING—CONDUCT—EFFICIENCY

The training of draft dogs is not complicated. It is not necessary for the trainer to have extensive special knowledge; a little tact is sufficient.

The fundamental principle is to oblige the animal to go forward, even against its will. It is necessary to oppose to a willful dog imperturbable firmness and a strong hand. It often happens during the first lessons that the dog will become afraid of the cart to which it is attached, and will turn around and even try at times to roll over. In such case the animal should not be struck, but firmly replaced in the normal position and obliged by material constraint to advance several paces. As soon as he has drawn the little cart a yard or two one should stop him, pet him and reward him. Afterwards the lesson will be begun afresh by making him cover a little longer distance. Any dog can be trained to draw a cart in the space of a week. When a dog has once learned how he takes pleasure in his new service, and soon manifests remarkable ardor in fulfilling his duties. Often he even has a tendency to go too fast, and it is necessary to make him go slow at will. A dog team accompanying a troop of infantry should not go faster than five kilometers per hour, including halts. This is a very good rate likewise for civil vehicles. The cart in which the conductor is mounted can make eight kilometers per hour. The draft animals are guided by means of an ordinary collar, having rings at the right and at the left, to which the reins are attached, or else by a special form of collar having on each side a small steel rod ending in a ring to which the line is fastened. Sometimes too, a little bridle with neither bit nor snaffle is used, to the noseband of which the rings for the guide lines are fastened. Finally, guiding by means of a wand gives excellent results. This consists in touching the right flank to direct the dog to the right, and the left flank, causing him to swerve to the left. However, this last method cannot be employed except by skilful guides.

Definite words of command must be chosen and adhered to. By pronouncing these words before touching the guide lines or using the guide stick, one will obtain in the course of time the obedience of the animal to the sound of the voice alone. The words of command used in Belgium are: "Right!" "Left!" "Forward!" "Turn!" and "Ou! Ou!" the latter meaning stop. (Rheul). The dogs of Alaska obey the following orders: "All Right!" means start; "Gee!" means turn to the right. "Haw!" means turn to the left, and "Whoa!" means stop.

Aside from specialized races, which are without peer for this purpose, the dogs of Greenland, Alaska, Kamchatka, etc., and the great montagnard dogs, the St. Bernards and the Léonbergs, and the Newfoundlands,

are not worth as much; they have not so much staying power. Some female dogs pull magnificently, but in general the males are far superior.

Dogs which have been pulling carts since their youth are able to continue this service to an advanced age, but to try to break in an old dog would merely result in his very rapid decrepitude.

The minimum size of the draft animal is 0.55 meter to the withers; smaller animals show fatigue too quickly because of the increased number of steps they are obliged to take. No quantitative relation can be established between the weight of the body and the power of traction, since the dog while utilising his own mass to draw the rolling load forward, draws mainly by arching his body and then extending his limbs. His efficiency therefore is a question of energy rather than of mass. The traction power of dogs has been singularly exaggerated by some authorities, thus, P. Mégnin writes in *L'Eleveur* (The Breeder): "A dog weighing fifty kilos (110 lbs.) is capable of pulling a weight of 400 kilos on a good road." But a dog cannot accomplish this except on a road as smooth as a billiard table. To keep within the domain of reality it may be said that an averagely good dog will draw without fatigue at a gait of five kilometers per hour, including halts, and over a distance of thirty to forty kilometers, if necessary, a useful load of 60 kilos (132 lbs.) supported by a cart of about the same weight. The aforesaid "average good dog" moreover need not himself weigh more than 40 to 50 kilos (88 to 110 lbs.).

Teams of two or three dogs give excellent service. It is easy to determine their power. The law of the composition of force of animals working in common is fully verified in this case, and we have found that if a dog hitched up alone will pull fifty kilos, two dogs yoked together will pull 98 kilos, and three dogs will pull 120 kilos.

The guides must take great care to keep watch on their animals and let them stop to take breath whenever necessary. Two or three minutes rest every half hour is sufficient; but it is rigorously indispensable. Moreover, draft animals should be trained to lie down at the command of the lifted arm, as do those trained for police dogs. The Belgians even take the precaution to carry in their carts a little clean board for their dogs to rest on so that they will be protected from the ground, which is often very damp and cold. The daily ration must comprise *at the minimum* 450 grams of meat and 1 kilogram of bread (.99 lb. meat, and 2.2 lbs. bread) when the animal is working several hours per day. This amount can be diminished on rest days.

V.—CARTS DRAWN BY DOGS

From the military point of view, and where small loads are concerned, the dog is a valuable motor power for troops in the first line, for it can go almost everywhere a man himself can go. In proximity to the enemy horses, mules, and donkeys are too much in the way and too readily visible from a distance. Moreover they are difficult to feed, while a dog will satisfy his appetite from the leavings of the table.

A great variety of employments at the front for carts drawn by dogs can be imagined. The jointed pole described above can be adapted to any sort of model by means of two bolts, and by its extreme flexibility it facilitates passage over the most uneven ground. As we have seen, it can be employed without traces. Thanks to the strength of the withers (upon which we have expatiated), one needs have no hesitation in adopting the two wheel cart, which is far less difficult to draw than one with four wheels, and whose weight, if well balanced, bears very slightly upon the shoulders and that only at certain moments.

For the narrowest communication trenches a barrel called a "passe-partout", very similar to a "diable", (a small truck) has been established upon an axle 0.6 m. in length. This permits the transportation of 50 kilograms (110 lbs.) of munitions. It can be transformed into a sort of armchair for carrying wounded men to the rear, by way of the trenches, which is impossible with real stretchers. In certain corps the revitualing of the companies with foodstuff is insured by a two-wheel cart made of steel tubes and capable of carrying 160 kilos (340 lbs.); four dogs are hitched to this. The employment of a similar vehicle is in prospect for the section of wireless telegraphy, where it will certainly render valuable service.

From the civil point of view, the draft dog is called on to assist war cripples, small peddlers, and various other persons in humble circumstances.

VI.—DOGS AS CARRIERS

Wherever the cart, light and small as it is, is unable to pass, the use of a saddle is indicated for reprovisioning with cartridges and 37 cm. shells. The first saddles for dogs constructed in 1914, by the Association for the Training of War Dogs, was composed of a girthed saddle cloth like the pad of a circus horse, on which is hung the pack saddle proper, but this system is bad, since in order to keep the saddle from turning it must be tightly clinched, and also because the load compresses the ribs. Here, as in the case of traction, we have been led, after many experiments, to give our preference to a light metallic frame-work (of aluminum); it is almost like that which constitutes the breast collar of the cart. Such a frame-work hangs on the animal by reason of its form alone and without its being necessary to clinch the belly. It forms, under the saddle, a sort of cuirass, protecting against lateral pressure by the load which hangs at the right and at the left. This load is contained in two sacks, united by a leather band, upon which is fastened a small flat triangle of iron, pierced by two holes, through which are passed bolts placed on the portion of the framework that forms the arch of the saddle. The iron triangle prevents it being necessary to fumble to hook on the sacks (which is inevitable when the preceding apparatus is used); at the same time the bolts slip into the corresponding holes by a single motion, so that one man can saddle and load the dog. Certain mastiffs, certain Arctic dogs, are able to carry as much as 20 kilograms (44 lbs.); but the average load of the dog used for military purposes is 10 to 12 kilograms (22 to 26.4 lbs.). Such a load permits rapid travel, a feature of great importance under the guns of the enemy.

A double saddle has been constructed for dogs yoked together; it consists of two breast collars held by a rigid aluminum frame, and each provided with a bolt placed upon the saddle. Each of these bolts engage in holes in a wooden bar (or yoke) covered with leather to which are attached the saddle bags. These, which are four in number, are hung on wooden bars which are joined to the first bar by means of a single bolt forming a pivot; two bags are placed between the dogs and the other two are outside with respect to the dogs.

This system of pivots is employed because of its flexibility; it leaves the animals room to pass each other as circumstances require; in such case the large transverse bar takes an oblique position and the saddle bags follow the movement of the body of each pack dog. The double saddle offers certain advantages. The rule of the composition of force necessarily applies in this case; however, two dogs yoked together can easily carry 30 kilograms (66 lbs.) at a running gait, while it is very exceptional for two separate dogs to carry 15 kilograms each at a trot, and this is because the load is better balanced upon the two points of suspension of the double saddle than on the back of a single animal—which probably more than compensates for the destruction of force.

It would appear that saddles for dogs will find a multitude of uses, both civil and military. The principal being established, applications will not be lacking.

To sum up, it is our opinion that the dog, either as a draft animal or as a pack dog, will be more and more employed; and in the present circumstances its aid is assuredly not to be disdained.

Electrolytic Iron and Nickel-Iron

The electrolytic preparation of pure iron is by no means so simple as is often assumed. When organic acids, citric or oxalic, *e. g.*, are added to the bath, as is frequently done to improve the galvanic deposits of metals, carbon is found in the iron. When all other impurities are successfully excluded, hydrogen and hydroxyde are not absent. The difficulty is that under ordinary conditions both iron and hydrogen are deposited from aqueous iron solutions, the equilibrium potential of hydrogen with respect to pure water being—0.41 volt, and that of iron in normal solution of $FeSO_4$ being—0.46 volt. Hence, argues Prof. R. Kremann—who has since 1913 been presenting papers on the electrolytic preparation of metals and alloys and on their metallurgraphic investigation to the Vienna Academy—the electrolyte becomes depleted of hydrogen ions in the immediate neighborhood of the kathode, and hydroxyl OH is deposited with the iron, that is to say, the iron deposit contains both hydrogen and oxygen. To prevent this, the electrolysis should be conducted in hot and in concentrated solutions, preferably of iron chloride, which is more soluble than the sulphate; for working at lower current densities, the solution might also be acidified, when the current yield would be lowered, however. As regards the hydrogen, in particular, we have to distinguish between the hydrogen gas discharged and the hydrogen dissolved in the iron, and Kremann and H. Breymesser show that, to keep the hydrogen percentage in the iron low, the gas pressure of the hydrogen should be high, not low. Electrolysing in a small boiler able to bear a gas pressure of 25 atmospheres, they found that their iron contained 0.038 per cent of hydrogen when deposited at ordinary hydrogen pressure and only 0.015 per cent when the hydrogen gas pressure was 20 atmospheres. The difference is small, and ordinary analysis would probably not have detected any hydrogen in the iron at all. They oxidized their iron with oxygen and determined the 1 or 2 milligrammes of water formed by this combustion of about 2 gramme of iron; a special determination of any oxygen present was not attempted, apparently, and we do not know how it could have been performed. Hydrogen is generally supposed to render the electrolytic iron hard and brittle, especially on the kathode side; Kremann inclines to the view—from this and many other experiments with iron of much higher hydrogen contents—that the brittleness does not directly depend upon the presence of hydrogen, but rather upon a certain structural arrangement to avoid which the bath should be hot (75 deg. C.) and neutral. There is no special mention of the part possibly played by oxygen in this connection; the point may be reserved for further study for our knowledge of the influence exercised by occluded gases upon metals is generally unsatisfactory in spite of many researches. In previous experiments with baths of ferrous sulphate and magnesium chloride, to which glycerol had been added in various proportions, Kremann had obtained some deposits which were hardly metallic, as they contained the two metals and their oxides, and up to 2 per cent of hydrogen and 5 per cent of carbon; the iron sometimes proved pyrophoric, both when rich in magnesium and when quite free of it, and the pyrophoric character seemed to be connected with the carbon percentages (from the glycerol). As regards nickel-iron alloys, Kremann tried to obtain a higher nickel grade by various ways, also by increasing the hydrogen gas pressure to 25 atmospheres; but he was not successful. When ferrous sulphate and nickelous sulphate are mixed and electroysed, the alloys deposited are poorer in nickel than the bath, and they are, moreover, brittle. This Kremann could not improve; the two metals do not appear to alloy properly when deposited together.—*Engineering.*

Why Animals "Play Dead"

(*Continued from page 291*)

species; but it does not follow that it is equally valuable in all cases. If we accept this, however, how shall we interpret an antagonistic reflex? Does this depend upon an inhibitory action directly involving the innervation of the contracted muscles? If this were true the mobilizing excitation would manifest itself by the simple relaxation of these muscles; but it manifests itself on the contrary by the contraction of different muscles, which are generally antagonistic to the first set of muscles. A very neat example of this phenomenon is furnished by the straightening out of the *stilbum splendidum* after it has been bent double: This is an active stretching directly provoked by the contraction of the extensor muscles, which break the resistance of the flexer muscles; the legs begin to move consecutively.

While less evident among the other arthropods, this phenomenon is also produced among them in the same manner; and as for the vertebrates, it is possible that the mobilizing reflex of batrachians also involves muscles which are antagonistic to the contracted muscles. However, the facts thus far recorded do not enable us to generalize. If we confine ourselves to the arthropods, observation leads us to believe that the contraction of the antagonistic muscles determines a sudden and forcible extension of the contracted muscles, and that there results therefrom an excitation which returns from the motor plane to the ganglion where it provokes a discharge of the accumulated energy. This explanation in no way pretends to give a definite solution of the phenomenon; it simply takes into account the facts actually known in the vast group of the arthropods. Perhaps it is equally available for certain vertebrates; in any case it does not appear to be directly applicable to birds and mammals, whose external manifestations furthermore are not in entire accord with those of the other vertebrata.

Meanwhile there is no need of bringing into such close agreement with each other phenomena whose apparent similitude possibly results from a simple convergence. Yet, one is strongly tempted to consider them as being derived from a fundamental property of the nervous system. At all events reflex immobilization can no longer be regarded as a peculiarity belonging to certain kinds of animals, and must no longer be interpreted in a sense both narrow and inexact. It has assumed a wider range. It has changed its direction in the biological point of view and its study, as yet barely outlined, deserves to be extended.

The Rolling of Ships

Notes on a Problem of Both Comfort and Safety

The subject of Rolling of Ships is one that should interest all who have been to sea, even for short voyages. How many there are who have longed for the perfectly steady ship! Apart from comfort, there are also the more important considerations of safety. On both grounds the subject is an important one, and is deserving of careful study. It is to be feared, however, that very few of those that spend their lives at sea understand even the rudiments of the phenomena attending rolling. This is probably due to the fact that in practically all that has been written on this subject advanced mathematics play a most important part, and, generally speaking, the mathematician is one who does not put the results of his investigations into plain English, but rather imagines that the conclusions are sufficiently obvious to all. The following notes have been written with a view to explaining the principal phenomena of rolling, without introducing any mathematics.

ROLLING IN STILL WATER.

In what follows, the rolling motions dealt with are transverse, as distinct from longitudinal, which are commonly known as pitching. Let us commence by examining the most simple rolling conceivable, that in still water. It may be objected that no ship will roll in still water unless she is forced to do so. That is quite true. But we are not so much concerned with the causes of rolling of a ship at sea, which are fairly obvious, as the study of resistances to rolling. Practically all our knowledge of resistance to rolling has been obtained from experiments made by rolling vessels in still water and allowing the motion to die down naturally.

If a ship in still water is heeled over by an external force and then suddenly let go, she will perform a series of oscillations that gradually die down, owing to the resistance offered by the water. These oscillations take place about a longitudinal axis that is not in itself fixed, but which may for all practical purposes be taken as fixed and passing through the centre of gravity of the ship. If the time taken for each roll is measured, it will be found that, at small angles, these times are the same. In other words, the rolling is "isochronous" at small angles. The time taken to roll from port to starboard or *vice versa*, is called the "natural period" of roll of the ship, and varies from about two seconds for small vessels, such as torpedo boats, to twelve seconds for large liners. Generally speaking, its value for any ship depends upon two factors: (1) the metacentric height, and (2) the grouping of the weights about the longitudinal axis through the centre of gravity, or what the mathematicians call the "moment of inertia" of the ship about that axis. The larger the metacentric height the shorter is the period of roll. The farther all heavy weights are removed from the longitudinal axis, or, in other words, the greater the moment of inertia, the longer is the period of roll. Now, an easy ship is one that has a long rolling period, and hence she should have a small metacentric reight and the weights should be winged as far as possible. Cargo-carrying ships, when light, fill up their ballast tanks. If these are deep down in the double bottom it may cause too much metacentric height, and a jerky ship. There are various ways of overcoming this, such as Raylton Dixon's system of wing tanks, which do not appreciably affect the metacentric height, while at the same time they add considerably to the moment of inertia about the longitudinal axis.

It must not be supposed, however, that the gain in easiness of motion by reduction of metacentric height can be carried indefinitely. If the metacentric height is zero, the greater the angle rolled through the smaller is the time of roll. If the metacentric height becomes negative the ship tends to take up a permanent list on one side or other of the vertical, and she will roll about one of these positions of equilibrium, and then suddenly fall over and roll about the other position, so that the motion is very erratic and may easily prove to be dangerous.

The most important experiments on still water rolling, in this country, were made by the late Mr. William Froude, who invented an ingenious apparatus by which to record the angles of roll. He caused a ship to roll by running a number of men from one side of the deck to the other, timing their movements so that they always ran uphill. Thus the old *Devastation* was caused to roll to 7 degrees on either side of the vertical in 18 runs made by 400 men. In passing, it may be noted that the theory of the popular novelist who allows the guns and other heavy weights to break adrift and roll from side to side to increase the rolling is a false one. In that case the motion is always downhill, and the effect would be to decrease the rolling.

From an analysis of the records of these experiments and mathematical considerations of the various factors that go to make up the resistance to rolling, Froude concluded that the main factors were skin friction, and the resistances due to appendages such as bilge keels, rudders, etc. In endeavouring to estimate the exact values of these, however, it became clear that other factors that had a very great effect in damping the oscillations were involved, and Froude considered that the wave-making effect of the bilge keels and sides of the ship probably accounted for the discrepancy. In comparatively recent years, however, it has been pointed out by Professor Bryan, of the National Physical Laboratory, that bilge keels cannot be considered as if they were dissociated from the ship like flat boards pushed through the water in directions at right angles to their surfaces, but that the action of the water in running round the corner formed by the outer surface of the ship and the bilge keel is to increase the velocity of the water past the bilge keel, and also to cause increased pressure upon the hull of the ship that might either increase or decrease rolling. He further demonstrated that the proper place to fit bilge keels is at the sharpest angle of the bilge, and that it is useless to fit them where the surface is flat.

While on the subject of the experimental investigation of rolling, it may be remarked that one of the greatest difficulties is to register accurately the angle of roll of a ship. The most common instrument used for this purpose is the ordinary pendulum. The readings of the pendulum, however, are only approximately accurate if it is suspended at the axis about which the ship is oscillating. If the point of suspension is above this axis, the recorded oscillation is greater than the actual angle, and *vice versa* if it is suspended below the axis.

ROLLING AMONG THE WAVES.

In considering rolling among waves the most simple case, and at the same time probably the most dangerous case to be considered, is that of a ship lying broadside on to a regular series of waves and having no motion ahead.

Consider, first of all, a deep, vertical floating body, such as a board so weighted that it can float on edge. Such a body has practically no stability. It would be found that, during the passage of the wave, it would incline towards the crest and away from the trough. Now take the case of the opposite extreme—that of a flat body, such as a raft, with a vertical mast. Such a body has practically maximum stability. It would be found that, during the passage of the wave, the mast would incline towards the trough and away from the crest.

Now, a ship is in some respects a combination of these two elementary floating bodies. Her extremities are represented by the board on edge—deep vertical sections, while the midship portion more nearly represents the flat raft. So that one portion tends to prevent the other from rolling. On the whole, however, she possesses some stability and, due to these stability forces, her masts are always seeking the position of the normal to the wave surface.

Mr. W. Froude made a mathematical study of the case of a ship lying broadside on to a uniform series of waves, assuming no resistance to rolling. The only forces acting on the ship are, therefore, the stability forces which tend to set her masts along the normal to the wave surface. The results of his investigations showed that the character and extent of the rolling depends upon the ratio between the natural period of roll of the ship in still water and the time taken between the passage of the crest and trough of the wave past any fixed point. If this ratio is large, in which case the natural period of roll of the ship is large and therefore her metacentric height is small, the waves will have little effect, and she will roll only to small angles in her own natural period. If, on the other hand, this ratio is small, in which case the natural period of roll is small, or her metacentric height is very great, she will roll with the wave, so that her masts are always along the normal to the wave surface and her period of roll is therefore that of the wave, whatever her own natural period may be. For intermediate ratios, where the metacentric height is neither very small nor very large, the rolling will generally consist of regular cycles in which the angles reached are at first small. Gradually they grow to a maximum, and then gradually die away again. These cycles are exactly reproduced one after another.

An exception to the general case is when the ratio of the periods is unity. In this case the change in direction of the stability forces exactly corresponds with the natural roll of the ship and the rolling becomes very great. If there were no resistances to rolling the ship would ultimately capsize. This phenomenon is known as that of "synchronism" between the period of the ship and that of the wave. It is a well-known phenomenon, and is the reason why a ship often rolls much more heavily in comparatively calm weather, with a slight uniform swell, than in very rough weather. The only method of checking the severe motion of a ship when synchronism takes place is by altering her course or speed relative to the waves.

Passing now to the case of resisted rolling of a ship broadside on to a regular series of waves, it is found that, generally, the motion consists of a number of cycles or periods during which the angles of roll gradually increase to a maximum and then fall away again to a minimum. These cycles grow more and more indistinct until, finally, the ship is rolling to equal angles on each side of the vertical and in the same period as the wave motion; even if this is greatly different from that of the natural period of roll of the ship. What precisely happens is, that at first the ship tries to oscillate in her own natural period and the fluid resistances are acting against this motion. On top of this the buoyancy forces are acting to set her masts always along the normal to the wave surface, and the direction of this normal is changing with the period of the wave. The latter set of forces persist, with the result that the ship is finally forced to roll to equal angles on each side and in the period of the wave. The oscillations so set up are spoken of as "forced oscillations."

In practice it is very seldom that we reach this stage as, generally, the sea does not consist of one regular wave system. The consequence is that the rolling experienced belongs to the cycles of motion that precede the forced oscillations, and it is during these cycles that the maximum angles are usually reached.—*By a Member of the Institute of Naval Architects, in The Shipping World.*

Quassia Extract as a Contact Insecticide

The authors describe numerous experiments to determine the efficiency of various extracts of Jamaica quassia wood and the effect of these extracts upon aphids. Medium-sized quassia chips soaked for two hours in water yielded 60 per cent of their total soluble matter, and during a second extraction, 15 per cent. Extraction for 24 hours did not increase the yield. The first extract was slightly more effective than the second in killing aphids. If the chips are boiled for 4 hours the yield of extract is half as much again. The yield of extract is greater, the larger the volume of water used: 3 grms. of chips yielded one-third more extract to 3 liters of water than to a quarter liter. The solubility of commercial quassiin powder is 1 in 3,000 of water, and 3 to 5 times as much in very dilute alkali and soap solutions. In testing the various extracts obtained upon aphids, it was found that soap solution extract, prepared at ordinary temperature, was the most effective and economical.

Commercial quassiin powder contains quassol, an inert and tasteless substance, and quassiin, an effective insecticide and intensely bitter. Exhalations from quassiin powder killed aphids, as also did the powder itself when dusted on them, whereas quassia powder and chips were ineffective. Quassia and quassiin spray solutions kill aphids when applied sufficiently strong, the solutions containing soap being the most effective. The spray is breathed into the spiracles of the insects and reaches the nerve tissue where it slowly affects the nerve cells, causing a state of coma. The general conclusion is that quassia extracts can never become general insecticides owing to the poor insecticidal properties of quassiin. The formula which yielded the most effective extract was 22 pounds of quassia chips soaked in 100 gallons of fish-oil soap solution for 24 hours. This extract was effective on two out of six species of aphids. Nicotine sulphate is a more reliable insecticide.—*Note in the Jour. Soc. Chem. Ind. on a paper by N. F. McIndoo and A. F. Sievers in J. Agric. Res.*

The Theory of Cyclones and the Method of Foretelling Them

When a cold region of the atmosphere corresponding to a strong pressure finds itself in contact with a warm region corresponding to a low pressure, there is produced a current of air descending from the cold region towards the warm region, wherein there is established an ascending current. Thus, in the equatorial regions, which are always superheated, there is a current of air which causes the trade winds, blowing from the pole toward the equator in the lower regions, while the upper current or counter trade wind blows from the equator towards the pole. As a result of this there occur meteorological disturbances, which are sometimes very serious. An interesting study bearing on this subject was made by the Captain of the Frigate Rondeleux upon the cyclones found in equatorial regions and the measures taken for safety by ships in their vicinity. This report, which appeared in the "Annales Hydrographiques,' 'was abstracted in "Le Génie Civil," from which we take the following paragraphs:

If the earth were immovable the direction of the winds produced would be that of normals to the isobars or lines of equal barometric pressure; the air, like any other fluid, would run towards the lowest level. Because of the rotation of the earth this direction is deflected towards the right in the northern hemisphere, and towards the left in the southern hemisphere. This deflection, which is nil at the equator, increases in direct ratio with the height of the latitude, and with that of the lowering of the coefficient of the friction of the air, that is if it exists in the higher altitudes. It then becomes almost parallel to the isobaric lines. It is this law upon which is based the Rule of Dove, generalized by Buys Ballot, whose application immediately brings in the law of cyclonic movements: "If one stands facing the wind and extends the right arm towards the northern hemisphere and the left arm towards the southern hemisphere one will have the low pressures to the right and a little to the rear in the northern hemisphere; and to the left and a little to the rear in the southern hemisphere." The cyclone is a vast whirlpool of aerial currents turning around a central axis about which the pressure is very low; the speed of the currents increases from the periphery towards the center; the winds V, V′, V″, V‴, are convergent except in the central portion, where they are perceptibly circular (Fig. I). The gradients G, G′, etc., are evidently directed from the exterior towards the interior. The term gradient is given to the difference of pressure expressed in millimeters of the mercury tube between two points of the normal and the isobars, divided from each other by the unit of distance (the arc of the equatorial degree). The convergence of the winds diminishes with the altitude; at from 2,000 to 3,000 meters in height their direction becomes perceptibly parallel to the isobars. Above, the movement becomes divergent, the masses of air which flow towards the center in the inferior regions are subjected to the ascending movement and escape towards the periphery in the super-regions. The currents being very humid, condensation occurs in the elevated regions, which forms dense clouds or give rise to torrents of rain. The movement of propagation of the cyclone is not due to the translation; it is caused by a vacuum, which is filled in on the spot where it is and reformed at one side in the direction in which the conditions are most favorable. The trajectory is the geometric locus following the points where the barometric low pressure is successively greatest. From the point of view of navigation, the cyclone is divided into two portions (Fig. 2): The dangerous semicircle in which the wind in the forward portion of the air movement tends to drive a ship forward from the storm-center to the point where the waves are worst, and the manageable semicircle in which a ship can sail away from the storm-center, driven by the wind to the rear.

Cyclones have their origin in the equatorial calms between 0° and 5° or 6°, and incline progressively towards the pole (Fig. 3), following a roughly parabolic trajectory whose apex, turned towards the west, is perceptibly found to coincide with the uttermost limit of the trade winds. They follow their trajectory with a speed which increases in general with the latitude and varies from 1 to 5 miles per hour in the vicinity of the equator, but sometimes attains a speed of from 18 to 20 miles per hour at the extremity of the second leg of the parabola.

In the equatorial regions where the heating of the atmosphere occasions the trade winds, as a result of a decrease of pressure and of the formation of an ascending current, it sometimes occurs that around a point which is more exposed to solar radiation there is produced a cyclonic movement which at the beginning is imperceptible.

A warm and humid current of air tends to rise, comes in contact with a current of cold air, whence proceeds condensation and a lowering of the pressure. The current may then be propogated in the most favorable direction, at the same time that the depression hollows out at the center. Thus the cyclone is formed.

During the passage of a cyclone over a given locality there will be perceived a lowering in barometric pressure which, beginning slowly, little by little becomes more pronounced, then becomes rapid, and finally

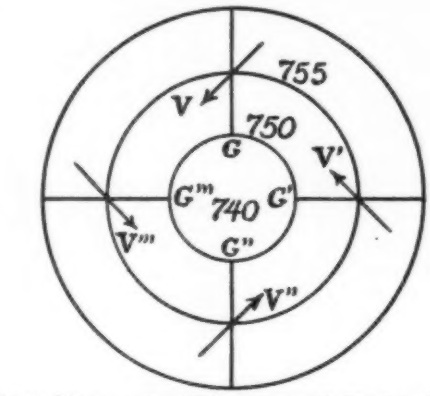


Fig. 1. Diagram of cyclonic movement in Northern hemisphere. The concentric circumference represent the isobars

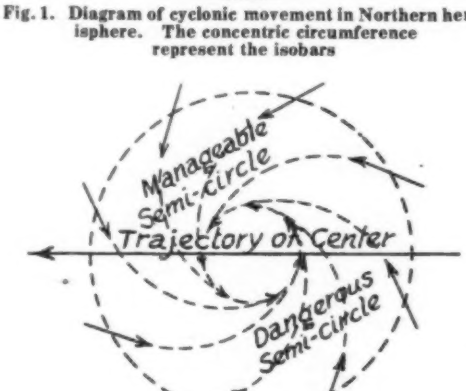


Fig. 2. Theoretical representation of a cyclone

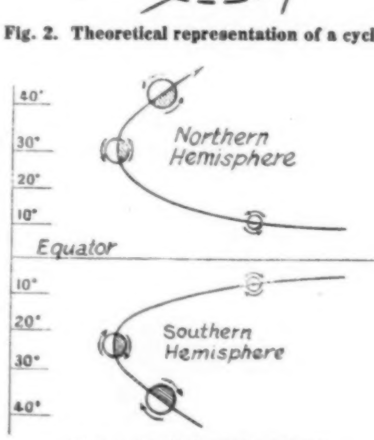


Fig. 3. Trafectory of cyclones

very rapid. It attains its maximum at the moment of the passage of the center of the cyclone. The barometer rises afterward along the line of the inverse curve.

The violence of a cyclone is a function of the horary or geographic gradient. It is regarded as destructive in nature when the gradient per mile exceeds 0.25 mm. It may be stated that the center of the storm passes at a slight distance when the wind remains almost steady or turns rapidly during the fall of the barometer.

The suction due to a profound depression at the center of the cyclone produces a certain degree of elevation of the level of the sea, which gives rise to the "tidal wave," which is propagated in every direction. The movement of the wave being more rapid than that of the cyclone it is one of the precursory signs.

The aspect of the sea and that of the sky also furnish valuable indices of the approach of the terrific air movement. Sometimes the sky is shrouded with a milky veil, or it may exhibit cirrus clouds which emerge from the central portion of the cyclone and which are visible at a long distance because of the great height at which they are situated.

At the center of the cyclone an abrupt calm takes the place of violent winds, this usually lasts only a few minutes and then the tempest rages once more, while the barometer begins to rise.

Sandfly Fever or Influenza

In the *Annali d' Igiene* of June 30th Professor G. Sampietro gives the reasons for the belief prevalent in Italy that the epidemic which began in the second half of last May and was prevalent in Spain and thence spread over Europe is identical with the so-called three-day fever or sandfly fever. The clinical picture of this epidemic may be thus summed up:

Sudden onset of fever, which as a rule remained high for two or three days, accompanied by severe muscular pains, localised specially in the back and lower limbs, with headache, prostration, anorexia, and coated tongue. In some cases there were signs of pharyngeal and tracheal irritation, which rarely developed into a catarrhal condition; in others there was gastro-intestinal disturbance. Convalescence was attended with marked debility, which lasted from one to two weeks. There was no skin eruption or enlargement of the spleen. The prognosis was favorable. Pfeiffer's bacillus, which is one of the specific agents in influenza, was only exceptionally met with, but, on the other hand, the municipal laboratory at Madrid demonstrated in the secretions the frequent presence of a Gram-negative diplococcus of the type of *Micrococcus catarrhalis*. Clinically the symptoms coincide exactly with those of the disease endemic in Italy and well known among the military population as *pappataci* or sandfly fever, while the late epidemic does not resemble dengue fever owing to the absence of relapses and exanthema, nor trench fever owing to the absence of recurrences and enlargement of the spleen and the ledcopenia; nor does it conform to true influenza on account of the want of symptomatic polymorphism, the typical duration, and scarcity of catarrhal elements affecting the respiratory system.

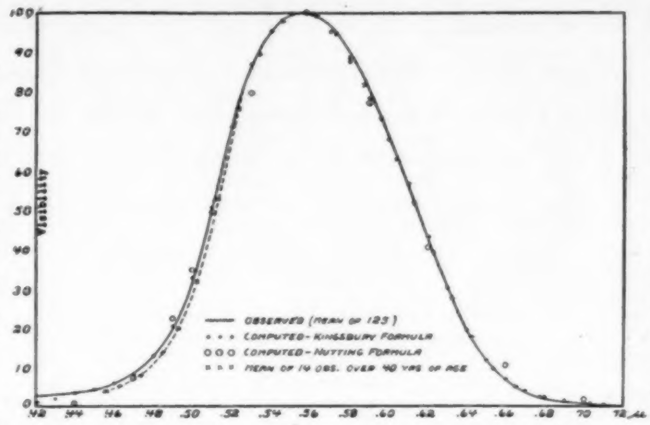
From the epidemiological point of view the diagnosis of sandfly fever derives confirmation from the fact that this fever usually prevails from the middle of May to the end of September, whereas influenza and trench fever are not epidemic in the summer. The epidemic of phlebotomus fever in Lemnos, described by Temporary Surgeon J. Lambert, R.N., in the *Journal of the R. N. M. S.* for April last had this seasonal incidence, the author taking the view that the absence of catarrhal symptoms would readily assure the differential diagnosis from influenza. The phlebotomus or sandfly is a small grey dipterous insect which makes its appearance about the end of May and disappears early in October, thus exhibiting a strange coincidence with the seasonal occurrence of three-day fever. Only the females bite during the night, their flight is inaudible, and they penetrate into bedrooms only when the atmosphere is completely tranquil, and at dawn return to their habitations in dark and damp cellars and deposit their eggs in underground localities where rubbish, wood, and vegetable detritus abound, or in dilapidated walls, gutters, and pipes. It can therefore easily be understood how difficult it is to prove the presence of the phlebotomi in any given epidemic. On the other hand, some account must be taken of the war conditions now prevalent. Everywhere a large quantity of wood, destined to supply material for the construction of defence works, barricades, and huts, has been transported, and doubtless with them also eggs of the phlebotomi, and with this accumulation of material there has been an aggregation of human beings in heated barracks or factories to establish conditions favorable to the development of the phlebotomi at altitudes and in localities which might seem to be incompatible with their life. Moreover, the rapid decline of the epidemic after a sudden and rather brief period of climax is more in favor of an infection transmitted by means of insects and related to their natural history than of a disease propagated by contagion.—*The Lancet.*

Focal Length of 40-inch Yerkes Refractor

Measurements with a steel tape in 1902-1903 showed that the distance from the outer surface of the crown lens to the focal plane was 746.7 in. (18,966 mm.) at 50° F.; the distance from center of air space to focal plane was 739.9 inches (18,793 mm.); the focal length computed from micrometer measures of star distances is 762 in. (19,354 mm.) at 50° F., this being verified from a photograph of the heliometer arc in Perseus. From these results it is seen that the telescope is equal in effective power to a telescope from 1 to 2 feet longer than is indicated by the length of the tube.—Note in Sci. Absts. on an article by E. E. Barnard in *Astron. Jour.*

The Sensibility of the Eye to Light of Different Colors

A recent investigation carried out at the Bureau of Standards, Department of Commerce, Washington has resulted in measurements of the relative sensibility of the eye to light of different colors. The total number of persons subjected to test was 130, of which number 7 were known to be color blind. A radiometer was used to determine the total energy of the source of light for each particular wave length and the visual brightness is expressed with reference to an equal amount of energy at each point in the spectrum. The visible spectrum extends from a wave length 0.4 micron (thousandth of a millimeter) to 0.75 micron.



The methods employed in obtaining the spectral-visibility curve were photometric. The complete visibility curve was determined with a flicker photometer by comparing the various spectral colors with a standard incandescent lamp. Similar measurements were made at five points in the spectrum using the equality-of-brightness method of photometry, the object being to determine whether there is a systematic difference in the measurements made by these two methods of photometry.

It was found that the various observers experienced little or no difficulty in making the photometric comparisons when using the flicker photometer. On the other hand, only a few observers were able to make accurate settings with the equality-of-brightness photometer, especially in the blue and in the red. This difficulty of forming a judgment of equality of brightness which is not influenced by differences in color seemed to be aggravated by the feeling that such a comparison had no meaning. In the yellow (0.586μ) about as many observers overestimated as underestimated in making the equality-of-brightness settings as compared with the flicker photometer, and the magnitude of these variations (0 to 50 per cent.) were within reasonable limits. On the other hand, when comparing less saturated colors, in the blue and in the red ends of the visible spectrum, a greater number of observers overestimated than underestimated their equality-of-brightness settings. Furthermore, the magnitude or this overestimation varied from 5 to 500 per cent. For the same observer these measurements varied greatly from day to day, whereas his flicker measurements were repeated to within several percent.

From the data obtained on 14 observers above 40 years of age, it appears that age has a perceptible effect upon the spectral-visibility curve. The same visibility curves were obtained for the right and left eye of a given observer.

The spectral-visibility curves of no two persons appear to be exactly alike, although there are some which are closely alike. When a spectral-visibility curve does not coincide with the average, there is usually a marked departure from the average visibility in a given spectral region. This gives rise to (1) wide visibility curves with the maximum shifted toward the red, i. e., "red-sensitive," (2) narrow curves with a sharp maximum in the green, and (3) curves with the maximum shifted toward the violet. A fourth group of observers has the average visibility in the red and yellow, but has a low sensibility in the blue, while a fifth group has the average sensibility in the blue but has a low sensibility in either the yellow or the red or throughout this entire region of the spectrum.

The data available indicate that 60 per cent. of the cases examined fall into three quite evenly divided groups (i. e., 20 per cent., roughly estimated, in each group) which are either (1) red sensitive, (2) blue sensitive, or (3) average. Similarly, 30 per cent. of the cases examined are quite evenly divided into three groups which fall below the average sensibility in either (1) the red, (2) in the blue, or (3) in both the red and the blue, thus giving rise to an apparently high sensibility in the green. One person in about 20 has a very wide visibility curve as compared with the average.

The point of maximum visibility is very different for different observers. The maximum visibility of the average of 125 subjects is at wave-length 0.5576 micron. The curve herewith has the relative visibility plotted as ordinates against the wave length as abscissas.

Carrilons—the Art of Bellringing

England is still "the ringing isle." Without doubt most of us love the music of bells, but "change-ringing," which is peculiar to this country, can only be described as a mechanical accomplishment of mathematical problems in which there are no musical considerations whatever, although in recent years composers of peals have paid some attention to the elimination—so far as possible—of changes containing unmusical cadences.

Bells for change-ringing are always diatonic—from five to twelve notes, while those for carillon use are chromatic, and, at best, four complete octaves in compass (49 notes). Another consideration is the difference in the construction scale as shown in the following table:

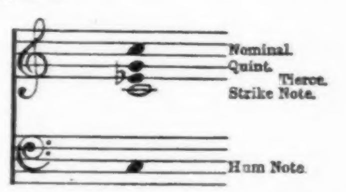
For Carillons.	Cwt.	Qrs.	For Change-Ringing.	Cwt.	Qrs.
1	1	2	G	6	0
2	2	0	F	6	1
3	2	2	E	6	2
4	3	2	D	7	1
5	5	0	C	8	0
6	6	0	B	9	0
7	8	2	A	11	0
8	11	3	G	13	0
9	16	0	F	17	0
10	20	2	E	20	2
11	28	0	D	28	0
12	40	0	C (Middle C).	40	0

The reason of the heavier weights in the smaller bells of the change-ringing scale is to prevent them being swamped by the larger ones, and for this purpose increased thickness is an absolute necessity. In a carillon when the design of one bell has been determined it does for all relatively. But most important is the method employed in the tuning of the bells. In earlier times it is certain that the principal aim of English founders was to tune correctly the fifth tone (Nominal) emitted by the bell, while the Continental founders spent all their attention in getting the two lowest tones (Hum Note and Strike Note) in perfect tune. The exact pitch of the bell is determined by the Strike Note. (See diagram.) After a lifelong study of the bells of Europe the writer has formulated the theory respecting the perfect tuning of bells in the following terms:

(1) A bell must be "in tune" with itself before it can be in tune with others.

(2) Every bell has at least five principal tones in it which can be accurately tuned.

(3) These principal tones are the Strike Note, Nominal, Hum Note (these three must be perfect octaves with each other), Tierce (minor 3rd), and Quint (perfect 5th), thus:



A bell of this pitch should weigh (approximately) two tons.

(4) All these tones must be in perfect tune with each other.

(5) The tone of a bell depends:

(a) On the consonance of its component parts.

(b) On the relative intensities of the various tones, which in their turn are dependent upon the minute accuracy of the sharply-defined height, width, and thickness proportions.

All these conditions can now be carried out to the accuracy of a single vibration. The bell is on a high plane musically when played from the clavier, as in the carillon proper, for which the most minute accuracy as to tune is an absolute necessity. Music in two, three, or more parts is performed, so that every note must be in perfect accord.

The carillonneur plays on a clavier arranged on the same principle as the manuals of an organ. There are two rows of keys, the upper representing the black and the lower the white notes of the ordinary keyboard. There are pedals from one to one and a half octaves in compass. The keys are struck with the closed hand, the little finger being protected with a leather covering, to prevent injury when playing. As the amount of tone produced depends upon the amount of force with which the key is struck, it will be understood that carillon playing requires strength, as well as celerity and skill. The connection between the key and the bell clapper is the same in principle as the tracker action used in organs. The bulk of the playing is done on the smaller bells. Chords are most effective when played arpeggiando; chromatic and diatonic scales can be rendered at almost any speed. All the music played must be specially arranged by the executant for the instrument on which he is playing owing to the variation which exists in the compass and size of the bells. This demands skilled musicianship. The Dutch Fischer (1738) quaintly and truly states that for carillon playing "a musician requires a thorough knowledge of music, good hands and feet, and no gout."—*The London Times.*

Methods of Rapid Nickel Plating

Nickel plating has been practised for about fifty years, and in all that time, up to the last two or three years, platers have been satisfied with the slow process of electrodeposition of nickel as practised by their fathers before them. That is, they have been content to deposit nickel with the low rate of 3 to 5 ampères per square foot. A few years ago "rapid nickel salts," claimed to permit of nickelling at two or three times the usual rate, were imported from Europe. These proved to be only mixtures capable of yielding more concentrated solutions than that enemy of progress, the double sulphate, which for so long has masqueraded as the plater's friend. The American plater ultimately learned to make up his own rapid solution, and as a result nickelling at 10 to 20 ampères per square foot is very common today.

The most recent step in rapid plating is the remarkable work of Kalmus and Barrows in plating with cobalt at 150 ampères per square foot, turning out commercial plating of high grade in three minutes. This achievement with cobalt suggested the desirability of obtaining similar effects with the cheaper nickel solution. In so far as the excellent results of the cobalt solution depend upon its extreme concentration (312 grammes of anhydrous cobalt sulphate per litre), it should be possible to duplicate them with nickel, since its salts are equally soluble. It is, however, in anode corrosion and in its absorption of hydrogen that nickel is inferior to cobalt as a metal for electroplating. The nickel anode becomes "passive" on the slightest provocation, and, instead of all the current dissolving nickel as is desired, a portion of it is spent in producing acid at the anode. Besides cutting down the efficiency of deposition, this acid causes hydrogen to be evolved in considerable quantity on the cathode, where some of it is absorbed by the deposit. Absorption of hydrogen by nickel renders it hard and brittle, and is likely to cause it to curl away from the metal on which it is deposited.

The addition of a small amount of some chloride to the sulphate solution generally employed for nickel plating is a well-known remedy for this passivity of the anode. Previous experience with hot nickel solutions indicates their use for overcoming these difficulties, since in a hot solution anode corrosion is greatly improved and absorption of hydrogen is lessened. A 25-gallon hot nickel bath was used at 125 to 150 ampères per square foot with great satisfaction, producing in five minutes a heavier deposit than is obtained in an hour with the usual rapid bath at 10 ampères per square foot. This solution contains nickel sulphate (single salt), nickel chloride, and boric acid. In spite of the extreme current density, the deposits were superior in quality and adherence to ordinary nickel plate.—*The Metal Record and Electroplater.*

Platinum in New South Wales

The recent discovery of platinum near Fifield has been officially investigated. The metal occurs as alluvial in a lead or placer deposit, which extends for about half a mile from the prospectors' claim, the depth to the wash varies from a few feet up to almost 80 feet, and the average thickness of pay dirt is 2 feet 6 inches to 3 feet. Over 400 loads from 10 claims have given an aaverge yield of 4 dwt. platinum and ½ dwt. gold to the load. The discovery is regarded as the most important made in this State for some years past, and will probably direct attention to the large known area of surface soil containing platinum in the vicinity.—*Austral. Ind. and Min. Stand.*

The Preservation of Decaying Stone*

With a View to the Conservation of Ancient Buildings

By A. P. Laurie, M.A., D.Sc., and Clerk Rankin, D.Sc.

THIS inquiry has been undertaken at the request of His Majesty's Office of Works with a view to dealing with the pressing problem of the preservation of decaying stonework in ancient buildings, and the following observations are the results of the preliminary experiments. It is therefore not merely a question of treating a stone which is at present free from decay, with some solution which will increase its durability. In the case of these ancient buildings the stone is already decayed to a certain extent and is in a crumbling condition. If this crumbling surface is cleaned off, the whole artistic value of the work is destroyed. It is therefore necessary to find something which will not only preserve the stone from further decay, but will reconstruct the existing crumbling stone.

Various substances have been put on the market with a view to stone preservation. These substances can be classified into certain groups. Some of them consist of materials of the nature of paraffin wax dissolved in a volatile solvent, the idea being to fill the pores of the stone with a neutral substance which will prevent further admission of moisture and will tend to bind the particles together. Others consist of solutions of materials like linseed oil, which are gradually converted by the action of oxygen into jellies, which are meant to fill the particles of the stone.

There are others which are intended to act upon the calcium carbonate or sulphate, producing insoluble compounds which are intended to bind the stone together. And there are others in which two solutions are used, with a view to form a precipitate within the pores of the stone itself.

In the case of the simplest form of preservative—a solution of a solid which is to be left in the stone on evaporation, like paraffin wax—the difficulty is to ensure that the solid will be left within the interior of the stone, the probability being that in most cases—as a result of capillary action—it will be found in the outer layer. This also probably applies to solutions which are intended to decompose spontaneously, as they will be drawn out by evaporation before decomposition takes place.

Better results might be hoped for in the case of solutions which are intended to act on calcite or calcium sulphate already within the stone, and so produce an insoluble precipitate, though, on the other hand, they involve serious questions as to how far it is wise to attack an existing cementing material with a view of forming a new one.

In practice, it has been noticed that in many cases preservatives, while producing temporary effect ultimately result in scaling.

The result of our experiments is to show that, even if a stone is sprayed several times with solutions of paraffin wax, it will not be rendered non-porous to moisture. It would be necessary to carry on the loading with paraffin wax to a point which would be quite impossible in practice, in order to obtain this result. But it has also been found that the paraffin wax has a marked effect on the process of evaporation which takes place afterwards. If the stone has been sprayed with paraffin wax before treatment with a potassium ferrocyanide solution, this spraying will only partially prevent the absorption of the solution, but tends to prevent on evaporation the crystallisation of the potassium ferrocyanide on the outside of the stone. The tendency, however, for such crystallisation is to take place principally just underneath the paraffin wax layer.

This layer is very thin, the solution of paraffin wax being absorbed readily by the stone, but on evaporation depositing the paraffin wax at, or near, the surface.

It is very evident, therefore, that a stone so treated with paraffin wax will still continue to absorb moisture, while the resulting products of decomposition will tend to collect just under the surface layer, and by crystallising out in that position, will ultimately produce flaking of the stone.

It is probable, therefore, that all stone preservatives of a greasy nature will be peculiarly apt to produce flaking ultimately on the stone. This raises the interesting question how far the deposit of greasy smoke particles is an important agent in the decay of stone.

It is obvious then that the first problem is to ensure that the particular material used permanently penetrates to a considerable depth within the stone itself, the first penetration being of no value, owing to the subsequent evaporation.

PHENOMENA INVOLVED IN THE USE OF TWO PRECIPITATING SOLUTIONS.

If a piece of stone about 1 in. in section was saturated with one solution and then poulticed on one side with another solution that would form a precipitate, we found in some cases that there was not only a copious precipitate on the side of the stone that was poulticed, but also a copious precipitate on the back of the stone, penetrating a little way into the interior; while in the centre of the stone, very little, if any, precipitation was visible.

THE CEMENTING PROPERTIES OF PRECIPITATES.

If the pores of the stone have been filled to a sufficient depth with an insoluble substance, are we justified in assuming that this substance will form a successful binding material, holding the particles of the stone together?

A large number of organic substances, such as linseed oil, paraffin wax, casein, resins, and gums, have the property of cementing particles together, and we also know from the study of stones themselves, that many substances also will act as a cement, even a crystalline body such as calcite forming a firm and strong cement between particles of quartz.

We are also familiar with the cementing properties of the jelloids produced during the setting of Portland cement, but in the case of stones, these inorganic cements have been produced very slowly and under special conditions, while in the case of Portland cement, the partial change into a gelatinous mass with the minimum quantity of water present is very different from the conditions of precipitation when a stone is treated in the usual way with two precipitating substances.

We are therefore not justified in assuming that even such substances as silica or alumina are going to act as a cementing material of any value when precipitated rapidly within the pores of the stone.

We decided in the first place to study what happens when a stone is treated with a simple solution whether of a salt in water or of a material like paraffin wax dissolved in a volatile solvent.

A large number of slabs, about 4 in. each way and about 1 in. thick, were cut from Cullaloe stone, a fairly porous stone, consisting almost entirely of silica, the analysis being as follows: Silicious matter 99.17%, Al_2O_3 0.11%, Fe_2O_3 0.07%, $MgCO_3$ 0.12%, combined water, etc., 0.46%, moisture 0.03%. The binding material between the particles of quartz is apparently a silicious deposit. This stone was therefore selected as not being likely to introduce any chemical complications in the experiments.

A series of wooden frames were made, with a flange, similar to picture frames, into which the slabs of stone could be fitted, and pressed up against a rubber washer, by means of clamps. In this way one surface of the stone was exposed, and could be treated by spraying with various materials, while at the same time, the creeping of the soution round the edges of the stone was prevented by the rubber washer. In addition to spraying, we ultimately adopted, as a much more effective method, covering the surface with paper pulp soaked with the solution with which we wished to treat the stone, and covering the paper pulp again with lead foil, the whole being pressed gently against the stone, so as to remain in contact. Such solutions laid on in this way would remain moist for some time, and if necessary could be renewed from time to time.

We also had a small machine constructed, consisting of a cylinder and a screw piston, for compressing and forming small cylindrical bricks, in order to test the behaviour of various solutions when mixed with pure white sand, ground Portland stone, and ground Ketton stone, as representatives of pure silicious sandstone, calcareous sandstone, and purely calcareous stone. By mixing these powders with various solutions, precipitates, and preservatives, and pressing them into bricks, it was possible to test, under very advantageous circumstances to the solutions used, how these solutions behaved, and to what extent they could be regarded as successful binding materials.

The first experiments were made to test the question as to how far, after treatment with the solution, capillary forces came into play, and removed the solution from the stone.

Some of the slabs of stone already described, after having been mounted in the wooden frames, were treated with the following salts in solution in water: Potassium ferrocyanide, sodium phosphate, sodium sulphate, ammonium phosphate, copper sulphate, copper nitrate, lead nitrate, copper chloride, potassium chromate, potassium arsenite, potassium bichromate, cobalt chloride, ferric chloride, barium acetate, chromium chloride, soap. The reason for the selection of these salts was that in most instances they lend themselves to detection by means of strong colouring actions.

With the exception of ferric and chromium chloride, soap, and potassium arsenite, in every instance it was found that as the stone dried the salt in solution was practically removed almost entirely to the surface layer, although before the stone was allowed to dry it had been saturated with the solution, which had begun to crystallise on the back of the stone.

The tendency, however, to rush rapidly out from the stone is not equally strong in the case of all these salts, potassium ferrocyanide being the most marked example of the kind.

Three salts, ferric and chromic chloride and potassium arsenite, and also soap, were found to be exceptions to the general rule, these salts remaining to a very large extent within the interior of the stone.

In order to test organic substances, we selected solutions of shellac in alcohol, and of paraffin wax in xylol, and, as has already been stated, we not only found that several sprayings of paraffin wax were not sufficient to make a stone really water-tight, but we also found that both these substances came to the surface of the stone during the process of drying. We also found that if the stone was first lightly sprayed with a solution of paraffin wax in xylol, and then treated with a salt solution, there was very much less tendency for the salt to crystallise on the outside of the stone, and that the distribution in the interior of the stone was better, but that there was a distinct tendency for an excess of the salt to be deposited just underneath the main paraffin wax layer, which lay from 1/16th to ⅛ of an inch below the surface of the stone. This result has already been referred to, as showing the danger of using greasy materials as stone preservatives, in that it tends to cause an accumulation of crystalline matter dissolved from the stone, just under the surface layer.

In order to check these experiments, we made a series of experiments with the bricks made of sand, with a view to finding out how the solution would be distributed under those conditions. In each case, of course, the solution was mixed evenly throughout the sand. The little brick was then allowed to dry, and examined; it was then, in many cases, immersed in water, to see what would happen under those conditions. Solutions of shellac, gelatin, paraffin wax, and albumin, were all tried, and in each case the result was formation on the outside of the brick—which was about 1 in. in diameter and about 2 in. long—of a hard layer about 1/16th of an inch thick, while if a hole was drilled inside the brick, the sand could be poured freely from the interior.

Some experiments, however, made with gelatin require to be discussed in more detail, as they illustrate a very interesting point in this connection. If a stone is treated with a liquid which solidifies without evaporation, the liquid should remain throughout the stone evenly distributed. That this is so was shown by experiments with bricks made with solutions of gelatin in water. In the case of a 1% solution the hardening was entirely superficial, the sand pouring freely from the interior; this was still true, but to a lesser extent, for the 3% solution; but in the case of the 5% solution the hardening of the sand brick took place all through.

While, in the case of all these inorganic solutions which we have tested, with the exception of ferric and chromic chloride and potassium arsenite, the result has been to bring the solid to the surface, there are no doubt exceptions to this rule, as it is possible to select substances which, when dissolved in water, lower the surface tension instead of increasing it, such as a solution of soap; and, moreover, as the surface tension of a mixture is the sum of the surface tension of the separate constituents, it is quite possible that the ten-

*An abstract of a paper read before the Edinburgh Section of the Society of Chemical Industry. Reproduced from the Journal of the Society.

dency of one substance in solution to cause crystallisation on the outside of the stone might be counteracted by the condition of another substance. Investigation in this direction was carried out and the effects of sugar, glycerin, starch, and soap were tried on aqueous solutions of various salts.

(1) Glycerin on every occasion was found to favor retention. Even with saturated potassium ferrocyanide only a very small amount crystallised on the surface.

(2) Soap produced practically no effect.

(3) Starch caused retention to a small extent but, on the other hand, did not permit of the stone taking up the solution readily.

(4) Glucose caused retention better than starch, but not nearly so great as glycerin.

METHOD OF EXPERIMENT.

(a) Stones soaked with concentrated solutions of potassium ferrocyanide, copper chloride, or barium chloride and allowed to dry gave large crops of crystals on the surface after 2 or 3 days.

(b) Stones soaked with the same concentrated solutions to which a small amount of glycerin, etc., had been added and allowed to dry, were compared with (a). Also after standing drying for 3 weeks, the stones (b) were broken and the interior tested. The tests showed whether the stones did or did not retain; *e. g.*, a Cullaloe sandstone slab treated with concentrated potassium ferrocyanide and a drop or two of glycerin was allowed to dry for 3 weeks, broken and the surface and the interior tested with drops of ferric chloride. The Prussian blue formed in the interior was as dense as that on the surface. Again, after drying for 9 months, the ferric chloride test still showed that the potassium ferrocyanide remained in the interior. It was also noticed that the stone had not got absolutely dry after 9 months, but still retained traces of moisture.

The effects of glucose and glycerine, nitrobenzene, aniline, methyl acetate, and ethyl benzoate on retention of alcoholic solutions were also tried. In all cases the addition of glycerin, etc., seemed to have no effect in causing the substances to remain inside the stone.

The result of these experiments is to show that while no reagent has been found to prevent the deposition in the outer layer of substances in organic solvents, the addition of a little glycerin to water solutions is sufficient to prevent this. We therefore recommend that in any practical tests of water-dissolved stone preservatives, the precaution of adding a little glycerin be taken.

In order to test how far various substances acted as cements, we made up a series of bricks mixed with various materials, directing special attention to the fluosilicates, as much attention has been directed to them lately as stone preservatives, more especially in Germany.

In the first place, we selected certain gelatinous precipitates which are generally supposed to act as cements, and having made up bricks mixed with sand and gelatinous precipitates and given them three weeks to dry, we examined their condition and then immersed them in water and examined their condition again. We found that precipitates of alumina and silica completely failed to act as cementing materials in the case of sand. If mixed with a little lime, the bricks were a little harder, but at once got soft in water. Aluminium fluosilicate showed a distinct tendency to come to the surface of the brick, and, whether alone or mixed with lime, the resulting brick was at once softened in water. Zinc hydroxide and calcium hydroxide, alumina and barium hydroxide, stannic acid, and stannic acid and calcium hydroxide, etc., failed to produce bricks which would stand the test of water; while casein, and zinc hydroxide mixed with calcium hydroxide stood the water test successfully.

The results obtained will be found in the following:

Sand.	Binding material.	Hardness after three weeks.	Hardness in water.
	Alumina	Crumbly.	Very soft.
	Silica hydrated.	Crumbly.	Very soft.
	Alumina + calcium hydroxide	Not quite so crumbly.	Soft.
	Silica hydrated + calcium hydroxide....	Not quite so crumbly.	Soft.
	Aluminium fluosilicate + calcium hydroxide	Harder.	Soft.
	Aluminium fluosilicate	Hard outside.	Very soft.
	Aluminium sulphate then barium hydroxide	Hard outside.	Very soft.
	Zinc hydroxide	Fairly hard.	Soft.
	Zinc hydroxide + calcium hydroxide....	Harder.	Hardish.
	Stannic acid	Powder.	—
	Stannic acid + calcium hydroxide.	Crumbly.	Very soft.
	Casein	Hard.	Hardish.

We next made up a similar set of bricks with Ketton stone. In this case, zinc fluosilicate, magnesium fluosilicate, and what is known as "Doppel" fluosilicate, as supplied by Hans Hauenschild, Berlin, failed to form permanent bricks. In each case the bricks were crumbly after two weeks, though those prepared with the Doppel fluosilicate were not so crumbly as others.

These results are of considerable importance, as it is claimed for these fluosilicates that in the case of calcareous sandstones, the resulting complex precipitate of fluosilicate of lime and zinc and magnesium hydroxides forms a reliable cementing material.

Any supposed preservative which depends for its success as a binding material on attacking the calcite which the stone contains should be regarded with profound suspicion. The results do not justify the use of a solution which is to depend upon its success in attacking the calcite existing within the stone, destroying the natural cement of the stone, in order to create another. If a solution is to be selected with this aim in view, it is difficult to imagine anything better than the fluosilicates, and it is for that reason that we have tested them so carefully, and have come to the conclusion that they are not reliable.

Such a process must be distinguished from that of Sir Arthur Church, in which case he is attacking the sulphate of lime in the stone, which is already a decomposition product, and therefore is not injuring the structure of the stone by the treatment to which it has been subjected.

The second conclusion which we have arrived at from these experiments is that a very large number of colloid precipitates, such as silica and alumina, cannot be regarded as cementing materials.

The direction, therefore, that the enquiry should take should be, if possible, to find an inorganic substance which is insoluble in rain water and the acids usually found in rain water, which, without requiring to attack in any way the natural combining material of the stone, will form a successful cement for particles of quartz.

THE CONDITIONS OF PRECIPITATION WITHIN THE STONE.

It is evident, from what has been already stated, that we have to look for our successful preservative in one of two directions, *i. e.*, we must either find a single solution or liquid which will solidify within the stone and form a successful combining material without showing any tendency to come to the surface, or we must obtain the result by a process of double precipitation, by the action of one solution upon another.

The difficulties of obtaining such a solution are sufficiently obvious, but it must not be ruled out of the ultimate possibilities. At the same time, it is very likely that the right method is to use a double solution, and therefore experiments on the precipitation within the stone itself require to be undertaken.

In order to test this question, we decided again to select precipitates, in the first instance, which, on account of their colour, would be fairly visible on the stone, without any reference to their suitability as stone preservatives, in order to get some guiding principles in the matter of such a precipitation.

The main difficulty of successful precipitation in the interior lies in the fact that the first precipitation will take place across the mouths of the capillaries, forming a diaphragm which will be more or less impervious to the passage of the salt molecules in either direction. At the same time we might expect to find the molecules or one of the salts might penetrate very much more easily than the molecules of the other, and therefore that the order in which the treatment of the stone took place would prove of considerable importance.

In most of these experiments we did not allow the stone to dry completely before applying the second solution; in some cases applying the second solution directly, before evaporation could have taken place; in other cases allowing partial drying before its application. We also in certain cases sprayed the stone lightly with paraffin wax on both surfaces, so as to tend to keep the first solution within the stone and give the precipitation a better opportunity.

The experiments on spraying the unwaxed stone showed that in every case the precipitation took place on the surface layer of the stone, and there was no proper penetration. The only successful experiments have been those made by means of the poulticing method, which has already been described. These results show that it depends very largely upon which salt solution is applied first, a fair precipitate being obtained inside in certain cases, while, when the treatment with the salts is reversed, practically no precipitation takes place at all. One of the necessary conditions, therefore, of success is to decide in which order the solutions are to be applied. It was decided to test the use of two different solvents for the salts. The idea of these experiments was to select two salts, which will result when mixed in a precipitate, one soluble in water and alcohol, the other insoluble in alcohol. If the stone is first treated with the water solution and allowed to dry leaving the salt precipitated throughout it, and if it is then treated with the second salt dissolved in alcohol, the second salt will be able to penetrate freely into the pores, owing to the fact that the precipitation will be delayed owing to the insolubility of the first salt in alcohol, and therefore we may hope to get the precipitation taking place within the stone.

FURTHER EXPERIMENTS ON PRECIPITATION OF SUBSTANCES INSIDE STONE.

Further experiments in this direction lead to the conclusion that the decisive factor in precipitation in the stone is the order in which the stone is treated with the solutions causing precipitation. Practically perfect precipitation was produced in the stone when potassium ferrocyanide was the second solution used, whereas when it was the first solution there was practically no precipitation in the stone.

The use of different solvents has certain advantages in so far that no waiting is required between treatment with the two different solutions. Waiting, however, is no real disadvantage owing to glycerin, etc., being able to keep the first substance in the interior of the stone.

Stone.	Treated first with:	Drying period.	Treated with:	Result.
Waxed	Lead nitrate (aqueous saturated) until crystals at back.	1 day	Potassium chromate (saturated) for 6 days.	Practically no precipitate inside. All round outside. 1.th inch.
Unwaxed	Borax.	3 days	Copper sulphate (saturated).	No precipitate inside. All round outside.
Unwaxed	Lead nitrate (aqueous saturated) until crystals at back.	1 day	Potassium chromate (saturated) for 6 days.	No precipitate inside. All outside. 1/16th inch.
Unwaxed	Potassium chromate (saturated) until crystals at back.	1 day	Lead nitrate (saturated) for 6 days.	Fair precipitate inside stone (irregular).
Waxed	Potassium chromate (saturated) until crystals at back.	1 day	Lead nitrate (saturated) for 6 days.	Fair precipitate inside stone (irregular).
Unwaxed	Copper sulphate (saturated).	1 day	Potassium ferrocyanide for 6 days.	Small amount of precipitate in layers in stone.
Waxed	Copper sulphate (saturated).	1 day	Potassium ferrocyanide for 6 days.	Precipitate going through stone in layers.
Unwaxed	Potassium chromate.	1 day	Lead nitrate.	No precipitate in stone.
Unwaxed	Copper nitrate.	3 hours and then waxed	Potassium ferrocyanide.	Little or no precipitate in stone. It penetrated but only gave streaks.
Unwaxed	Copper sulphate (aqueous).	None	Alcoholic caustic potash for 2 days.	Black copper oxide well through stone.
Unwaxed	Caustic potash (alcoholic).	2 hours	Aqueous copper nitrate.	No precipitate in stone.
Unwaxed	Copper chloride (alcoholic).	None	Aqueous sodium sulphide.	Poor precipitate of copper sulphide in stone.
Unwaxed	Sodium sulphide (aqueous).	None	Alcoholic copper chloride.	Very good precipitate in stone.
Unwaxed	Ferric chloride (alcoholic).	None	Aqueous potassium ferrocyanide.	Very fine precipitate in stone.
Unwaxed	Potassium ferrocyanide (aqueous)	None	Alcoholic ferric chloride.	Very poor precipitate in stone.

The result, then, of these experiments on precipitation is to show that, in the first place, methods of spraying with two solutions in water seem to be very unlikely to yield satisfactory results; and that some method of poulticing is apparently essential for success, so as to ensure deep penetration of the solutions. In the second place, if prevention of the salt crystallising on the outside can be obtained, it is possible to get a fairly uniform precipitation within the stone. And, in the third place, even where salts are used which tend to crystallise on the outside, the use of the two solvents results in a very uniform precipitation if the stone is not allowed to dry between the two treatments.

While we do not pretend for a moment that these results can be regarded as more than preliminary, we think that they have been sufficient, in the first place, to show that the problem has not been successfully solved by the existing stone preservatives, and also to show the complex nature of the problem, and the directions in which a solution of it is to be looked for.

These are as follows:

(1) The solution with which the stone is treated—or if two solutions are to be used, the first solution with which it is treated—must be of such a kind that the

resulting solid is uniformly distributed throughout the stone, and does not tend to come to the surface. It must, therefore, be a solution in which the surface tension tends to diminish instead of increase on concentration.

(2) The resulting cement—whether due to the evaporation or solidification of one solution, or to the precipitation of one solution by another—must be a material which is not readily attacked by air, water, or the acids usually present in rain water.

(3) None of the solutions used should act upon the natural cementing material of the stone, or should depend upon that action in order to produce a binding material.

(4) The resulting solid—whether produced from one or from two solutions—must be one which has been proved by severe test to act as a cement for particles of silica.

(5) If two solutions are to be used it is very important to study carefully the right order of application in order to ensure proper penetration, or to use two different solvents in the way already described.

The Rapid Cure of Hysterical Symptoms in Soldiers

By A. F. Hurst, M.A., M.D. Oxon., F.R.C.P., Physician and Neurologist, Guy's Hospital; Officer in Charge of Seale Hayne Military Hospital, Newton Abbot, and

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Increased experience in the treatment of the hysterical symptoms which form one of the largest classes of war neuroses has led to gradual simplification of methods and increasing certainty and rapidity of cure.

From the earliest days of the war we realised that recent cases could generally be cured quickly and completely by a variety of methods, including simple persuasion and re-education, suggestion with the aid of electricity in the waking state, and suggestion under hypnosis or light anæsthesia. But occasionally improvement was slow and incomplete, and when patients reached us after being under treatment for long periods in other hospitals we did not expect such good results.

Even in hysterical aphonia and mutism, which almost invariably disappeared after a few minutes' treatment, sometimes after lasting for a year or more, the more serious speech defect was often followed by a stammer, which might require careful re-education for several weeks before complete recovery occurred. Indeed, we regarded stammering as one of the conditions in which a rapid cure was rarely possible even in early cases.

Another condition of this sort was tremor: we were confirmed in this conclusion by the opinions which had been expressed by two such distinguished neurologists as Babinski in Paris and Oppenheim in Berlin, both of whom regarded the tremor of soldiers as a special neurosis of emotional origin, which differed from hysterical symptoms in being much less amenable to psychotherapy. We were fortunately less influenced by the writings of Babinski and Froment on reflex neuroses, acceptance of which would lead to the belief that contractures associated with vasomotor and secretory changes are not hysterical and could at the best improve very slowly with physicotherapy.

During the last few months we have come to realise that stammering and tremor, except the fine tremor of the hands and head in pure neurasthenia and hyperthyroidism, and all the cases we have seen which corresponded with Babinski and Froment's description of reflex contractures, are as amenable to treatment as hysterical mutism, aphonia and paralysis, and that they are undoubtedly of pure hysterical origin.

RAPID CURE.

Our more recent experience has shown that the prolonged re-education which we had thought was required to convert into a cure the great improvement which followed the active treatment of long-standing cases directly after admission is unnecessary, and we are now disappointed if complete recovery does not occur within 24 hours of commencing treatment, even in cases which have been in other hospitals for over a year.

If a man with severe hysterical paraplegia of many months' duration is taught to walk in half an hour, and treatment is then discontinued on account of his fatigue, although his gait is stiff and unsteady, he will probably not walk normally until he has undergone re-education for several weeks. But if the officer in charge not only ignores the patient's fatigue, but also his own, and continues the treatment for another half-hour or hour, or even for two or three hours, the patient will end by walking with a normal gait, although, of course, some time will elapse before he completely regains his strength. In the same way a mute or aphonic soldier, who stammers on recovering his voice, should not be left until the stammer is also cured, or he will only recover completely after receiving daily lessons for some weeks.

It is thus not merely in casualty clearing stations that immediate recoveries should occur in the vast majority of cases, but they should occur with equal frequency in hospitals in England. Unfortunately, the hysterical nature of many cases is not always recognised, and patients are kept in bed for months together for the supposed organic results of shell shock or spinal concussion, or are regarded as suffering from some incurable disease of the spinal cord. Thus we have had seven cases of hysterical paraplegia sent in as disseminated sclerosis and two as primary lateral sclerosis in the last 12 months. Rapid recovery followed the recognition of the true nature of their condition.

Many errors in diagnosis are quite excusable, as organic conditions are often very closely simulated, and without the large experience gained in special hospitals during the war we should have had much difficulty in reaching a correct diagnosis. It is for this reason that all cases of nervous disorders in soldiers, apart from those due to actual injury of the central nervous system or peripheral nerves, should be admitted direct or transferred as quickly as possible into special hospitals, the number of which should be largely increased. Hysterical symptoms would then be diagnosed at an early stage and appropriate measure would be taken to cure the patients at once. Men would be fit to return to duty or to earn their living in civil life in a few weeks instead of having to be invalided from the service more or less completely incapacitated after being in hospital for months or even years.

PROGNOSIS.

The question may be asked whether such cures are permanent. Experience shows that relapse is rare if a cure is obtained within three or four weeks of the onset. It is more common the longer the symptoms have lasted, but the liability to relapse is greatly reduced if the patient is given open-air work and kept under observation at the hospital where he was cured for a few weeks before returning to duty. It is for this reason as well as for the sake of the numerous neurasthenic and psychasthenic patients that country hospitals with sufficient grounds to give opportunities for a variety of open-air employment whilst still under military discipline are so desirable.

In very long-standing cases it is generally wise to invalid the patient from the service even if recovery is complete, as a return to the front would be likely to cause a relapse, particularly if the patient is also neurasthenic or otherwise unfit, but a pension of more than 20 or 30 per cent. should never be necessary. So far as we know relapses have not occurred after discharge, except during air raids among men living in London. This is an additional argument, if any are still necessary, for the removal of all patients, officers as well as men, suffering from war neuroses out of London.

ESSENTIAL POINTS IN TREATMENT.

We have almost entirely given up hypnotism in the treatment of hysterical conditions, as our results were uncertain, and we have seen so many patients with whom prolonged treatment by hypnosis before admission had proved unavailing and had even given rise to new symptoms. Suggestion with the aid of electricity we rarely employ, except in some cases of flaccid paralysis, in which contractions produced in the paralysed muscles powerfully appeal to the patient's mind, and in resistant cases of speech defects.

Our method now is simple persuasion and re-education continued with manipulation. But an all-important preliminary is the creation of a proper atmosphere. After admission the sister encourages the patient to believe that he will be cured as soon as the doctor has time to see him. If paraplegic or mute, two or three patients in the ward who have been rapidly cured of paraplegia or mutism tell him of their cure. The medical officer sees him some hours later, and after examining him and coming to the conclusion that the condition is hysterical he tells him as a matter of course that he will be cured the next day. By the following morning the patient is fully convinced that the hoped-for cure will take place. As the medical officer is equally convinced that he will cure the patient, the two essentials for recovery are present. The nature of the actual treatment is really immaterial, but simple persuasion has the great advantage of making the patient take an active part in his own cure, and it removes any suspicion of charlatanism from the proceedings.—*The Lancet.*

Salvaging Sunken Ships

From January, 1915, to the end of May, 1918, 407 ships sunk by the Germans in British waters have been salvaged, according to details of the work of the Admiralty Salvage Department, just made public in the press.

Up to December, 1917, 260 ships were recovered. In the present year to the end of May, 147 have been salvaged, the increase being due to improved methods, and not to the greater activity of U-boats.

Among the difficulties encountered has been the emission of poisonous gases from the rotting cargoes of sunken ships which sometimes have caused the loss of lives. One salvage ship was torpedoed while working on a wreck, while sometimes the work of weeks is destroyed by one rough sea. Feats performed by the salvage department include the raising of a large collier sunk in twelve fathoms of water and involving a dead lift of 3,500 tons. Another vessel was raised 15 fathoms by the use of compressed air.

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